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SPORT FISH STUDIES

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STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

RUSSIAN RIVER SALMON SOCKEYE STUDY

By

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Volume 25 Study G-II

RESEARCH PROJECT SEGMENT

State: Alaska Name: Sport Fish Investigations of Alaska

Project: F-9-16

Study No: G-II Study Title: SPORT FISH STUDIES

Job No: G-II-C Job Title: Russian River Sockeye Salmon Study

Cooperator: David C. Nelson

Period Covered: July 1, 1983 to June 30, 1984

ABSTRACT

A creel census was conducted during the 1983 Russian River sockeye salmon, Oncorhynchus nerka (Walbaum), sport fishery to determine harvest and angler participation. Census data revealed 31,890 man-days of angler effort were expanded to harvest 24,360 sockeye salmon. Early and late runs contributed 8,360 and 16,000 salmon, respectively, to the harvest. Sport fishermen harvested 30.6 percent of the sockeye salmon population which returned to the Upper Russian River drainage in 1983. Seasonal catch per angler hour was 0.117.

The incidental harvest of coho salmon, Oncorhynchus kisutch (Walbaum), pink salmon, Oncorhynchus gorbuscha (Walbaum), Dolly Varden, Salvelinus malma (Walbaum), rainbow trout, Salmo gairdneri Richardson, and Arctic grayling, Thymallus arcticus (Pallas), in Russian River as determined by Statewide Harvest Survey are presented and discussed.

Spawning escapements of early and late run sockeye salmon to Upper Russian Lake drainage were determined by weir at the outlet of Lower Russian Lake. Early and late run spawning escapements above the weir were 21,200 and 34,000 salmon, respectively. Early run escapement exceeded the minimum escapement goal of 9,000 fish by 135.5 percent. Late run escapement exceeded the minimum escapement goal of 30,000 by 13.3 percent. An additional 44,000 late run sockeye salmon spawned below Russian River Falls in lower Russian River. This is one of the highest spawning escapements recorded in this area. Total late run escapement to the Russian River drainage in 1983 was 78,000 sockeye salmon.

Management of the 1983 recreational fishery is discussed, as are escapement goals for early and late runs. It is concluded that Upper Russian Lake is at or approaching carrying capacity. Present minimum escapement goals of 9,000 early and 30,000 late run sockeye salmon are appropriate and should be retained. Optimum production from Upper

Russian Lake is realized when the sum of the early and late run escapements approximate 62,500 fish.

Early run Russian River sockeye salmon are harvested only by the Russian River sport fishery. Late run fish are harvested commercially in Cook Inlet and by sport fishermen in both the Kenai and Russian Rivers. Data indicate the exploitation rate of this stock in some years may be as high as 90 percent. The majority of the late run catch (mean of 64.3 percent) is taken by the Cook Inlet commercial fishery. It is concluded that when the exploitation rate in this fishery exceeds 72 percent, the Russian River late run sport fishery will in all probability be closed to ensure the minimum spawning goal is achieved.

Analysis of scales collected at Lower Russian Lake weir indicated 48.1 percent of the early run was comprised of 6-year fish of age class 2.3. Age classes 1.3, 1.2, 2.2 and 3.3 contributed 37.4, 11.2, 2.8 and 0.5 percents, respectively. The contribution of age class 1.3 is approximately twice the historical contribution of this component. Mean length of early run fish sampled was 585.5 millimeters (23.1 inches). Male to female sex ratio was 1:0.9. The late run was dominated by age class 1.2 (73.7 percent). Other age classes represented were 2.2 (12.6 percent), 1.3 (8.0 percent) and 2.3 (5.7 percent). This age structure represents a departure from the expected age class composition in that age class 2.2 historically has contributed a mean of 65.0 percent. Mean length of late run fish was 542.2 millimeters (21.4 inches). Male to female sex ratio was 1:1.7.

Fecundity of early and late run sockeye salmon averaged 3,063 and 2,593 eggs per female, respectively. Early run fish averaged 5.6 eggs per millimeter of length and 1,380 eggs per kilogram of body weight. Late run salmon averaged 4.7 eggs per millimeter and 1,168 eggs per kilogram. Early run fish were the smallest (both length and weight) sampled since fecundity investigations were begun in 1973.

Water velocities through Russian River Falls were low during the 1983 sockeye salmon migration. Use of the fish pass at Russian River Falls was not required.

Climatological data were collected at Lower Russian Lake weir. Air and water temperatures approximated historical data. Flow rates were less than the mean Russian River discharge as determined by U.S. Geological Survey from 1947-1954.

KEY WORDS

Alaska, Kenai Peninsula, Russian River, sockeye salmon, harvest, spawning escapement, production, age structure, fecundity, escapement goals.

BACKGROUND

Russian River is a clear stream adjacent to the Sterling Highway 9.6 km (6 mi) west of the Kenai Peninsula community of Cooper Landing, and

approximately 160 km (100 mi) south of Alaska's largest city, Anchorage. The stream bisects Federally managed lands. To the south, land is administered by the Kenai National Wildlife Refuge and to the north by the Chugach National Forest. A privately owned ferry at the Kenai and Russian River confluence transports anglers to the south bank. In an average year, this area (1.6 km or 1 mi) receives 50% of all angler effort as fishermen attempt to intercept the runs prior to their entry into Russian River. The remaining effort occurs on 3.2 km (2 mi) of Russian River above the confluence of the Kenai and Russian Rivers. Figure 1 depicts the general location of Russian River and other pertinent landmarks.

Sockeye salmon sport fishing occurs from a marker 548 m (600 yds) below Russian River Falls to a marker 1,646 m (1,800 yds) below the confluence of Kenai and Russian Rivers, a distance of 4.8 km (3 mi). This area is commonly known as the "fly-fishing-only area", and from June 1 through August 20, terminal gear is restricted to coho (streamer) flies with gap between point and shank no greater than 9.5 mm (3/8 in).

The area between a marker below the ferry crossing and a marker 640 m (700 yds) upstream on Russian River is closed to all fishing from June 1 through July 14 to provide additional protection to early run sockeye salmon which concentrate in this area prior to continuing their upstream migration (Figure 2). Sockeye salmon sport fishing does occur in the Kenai River below the "fly-fishing-only area" with conventional tackle. Harvest and effort here is minimal due to the glacial nature of the Kenai River.

Lower Russian River from its confluence with the Kenai River upstream for 3.2 km (2 mi) is of moderate gradient. Above this point the stream flows through a canyon of considerable gradient know as Russian River Falls. Sockeye salmon have been delayed and/or totally blocked by this canyon on several occasions due to a velocity barrier caused by atypically high water. Documented mortalities of both early and late run sockeye salmon were associated with this barrier in 1971 and 1977 (Nelson, 1978). In 1979, a fish pass was constructed around the falls to enable salmon to negotiate this segment of Russian River at all water levels.

Russian River sockeye salmon runs are bimodal; i.e., there are two distinct runs. Early and late run total returns have averaged 27,790 and 54,930 fish, respectively, from 1963 through 1982. Migrational timing and entry into the fishery for these stocks have been previously presented (Nelson, 1976-1977). Resident and anadromous fish species present in Russian River are presented in Table 1.

Lower Russian Lake, 0.8 km (0.5 mi) above Russian River Falls, supports a Dolly Varden and rainbow trout fishery. Physical characteristics of the lake have been described (Nelson, 1979). Sockeye salmon spawning in this lake is limited to less than 500 late run fish. Observation indicates Lower Russian Lake is utilized by rearing chinook and coho salmon. These species spawn in upper Russian River between Upper and Lower Russian Lakes. Coho salmon also spawn in Upper Russian Lake tributary streams.

Table 1. A List of Common Names, Scientific Names and Abbreviations of Fish Species Found in Russian River Drainage.

Common Name	Scentific Name and Author	Abbreviation
Sockeye Salmon	Oncorhynchus nerka (Walbaum)	RS
Chinook Salmon	Oncorhynchus tshawytscha (Walbaum)	KS
Coho Salmon	Oncorhynchus kisutch (Walbaum)	SS
Pink Salmon	Oncorhynchus gorbuscha (Walbaum)	PS
Dolly Varden	Salvelinus malma (Walbaum)	DV
Rainbow trout	Salmo gairdneri Richardson	RT

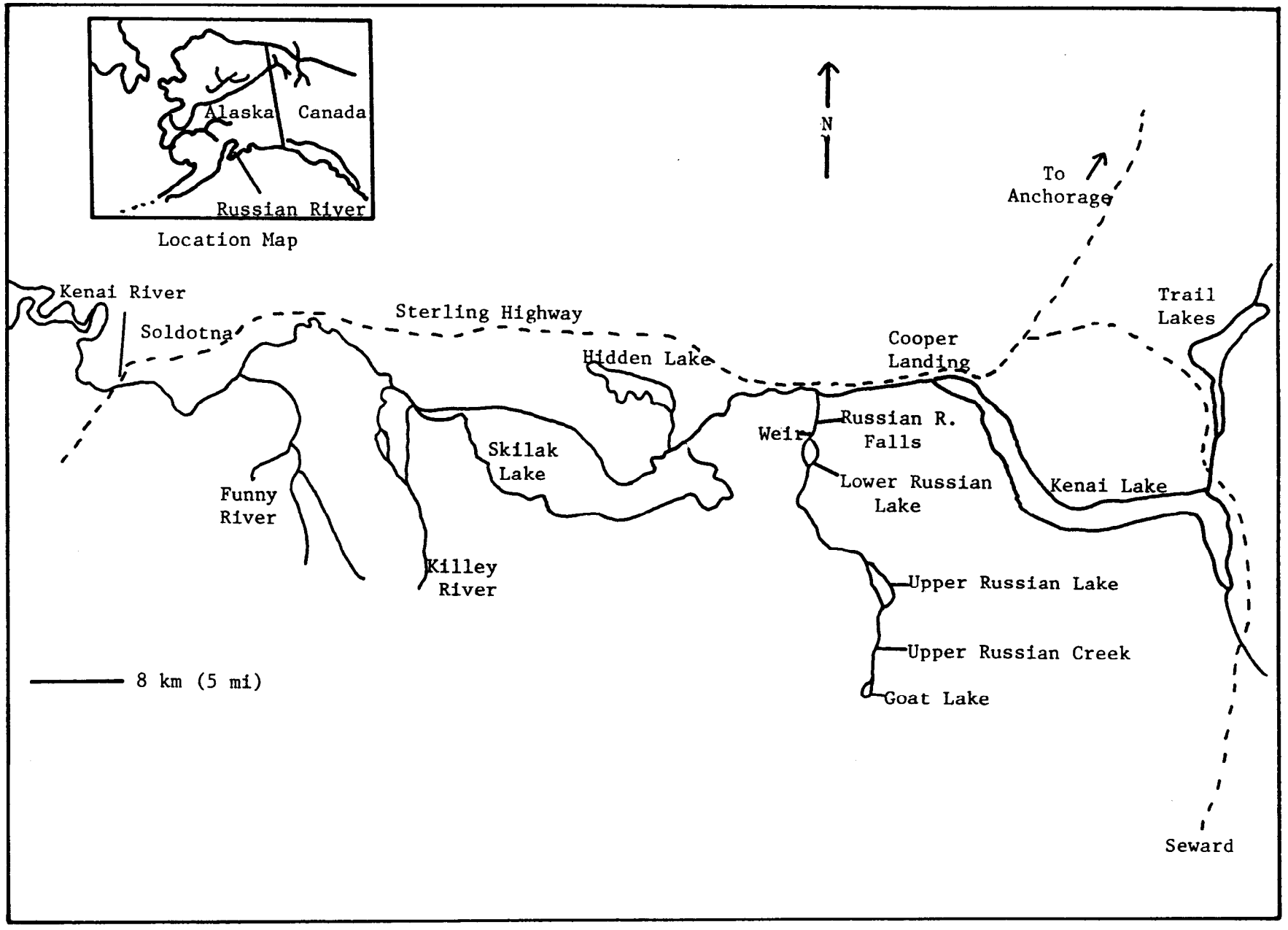

Figure 1. Schematic Diagram of the Kenai River Drainage.

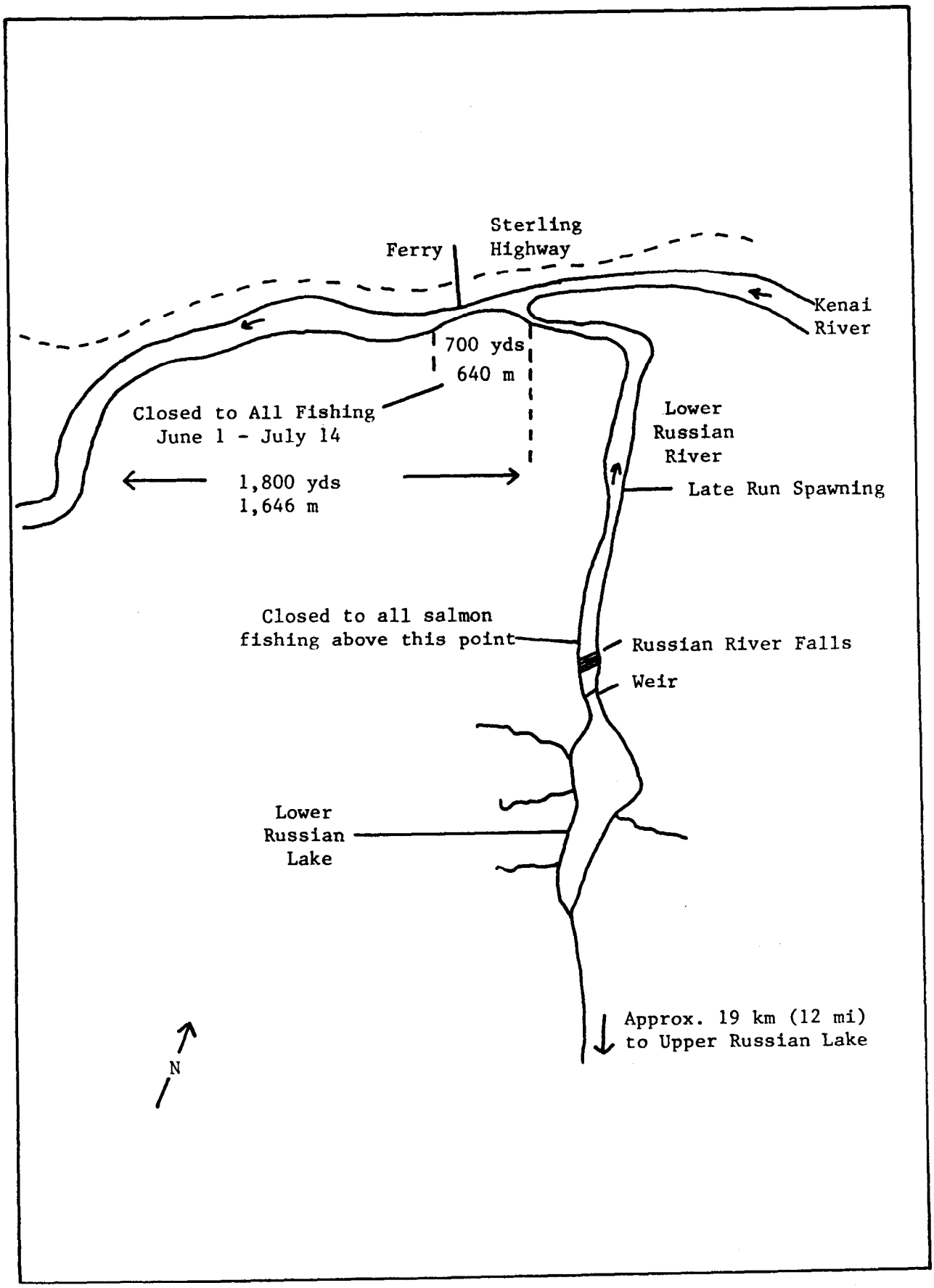

Figure 2. Schematic Diagram of Lower Russian River and Kenai and Russian River Confluence (Not to Scale).

Upper Russian River enters Lower Russian Lake from the south and connects Upper and Lower Russian Lakes. Nelson (1976) has presented a detailed description of this stream and the Upper Russian Lake drainage. Figure 3 depicts the Upper Russian Lake drainage and delineates the spawning areas of both early and late runs.

Management and research associated with the Russian River sockeye salmon sport fishery has been conducted by the Sport Fish Division of the Alaska Department of Fish and Game since 1962. Prior information pertaining to this fishery has been presented by Lawler (1963-1964), Engel (1965-1972) and Nelson (1973-1983).

Despite a restrictive sport fishery which restricts harvest methods and protects salmon in areas where they are concentrated, recreational demands upon the Russian River sockeye salmon resource has, at times, been greater than the stocks could sustain. This is evidenced in that the Sport Fish Division has closed all or part of the fishery on 19 different occasions since 1969 to increase spawning escapement levels. Numerous emergency openings and closings of the Russian River sockeye salmon fishery indicate it is the most intensely managed sport fishery in Alaska.

The Russian River program is currently directed toward "in season" evaluation of stock status to determine the effects and effectiveness of current regulatory practices. Research activities emphasize the collection and evaluation of life history data. Objectives include determination of optimum escapement goals for both runs and ultimately predictions of sockeye salmon returns to Russian River.

RECOMMENDATIONS

1. Continue the present Objectives of this study.

OBJECTIVES

1. To determine adult harvest of sport caught early and late run Russian River sockeye salmon during June, July and August in the Russian River drainage.

2. To collect and analyze biological data concerning abundance and migrational timing of adult sockeye salmon in the Russian River drainage from June to September.

3. To determine age class composition of adult early and late run Russian River sockeye salmon escapements enumerated at Lower Russian Lake weir.

4. To determine the fecundity of early and late run female sockeye salmon and to determine the relationship between fish length and mean number of eggs per sockeye salmon female.

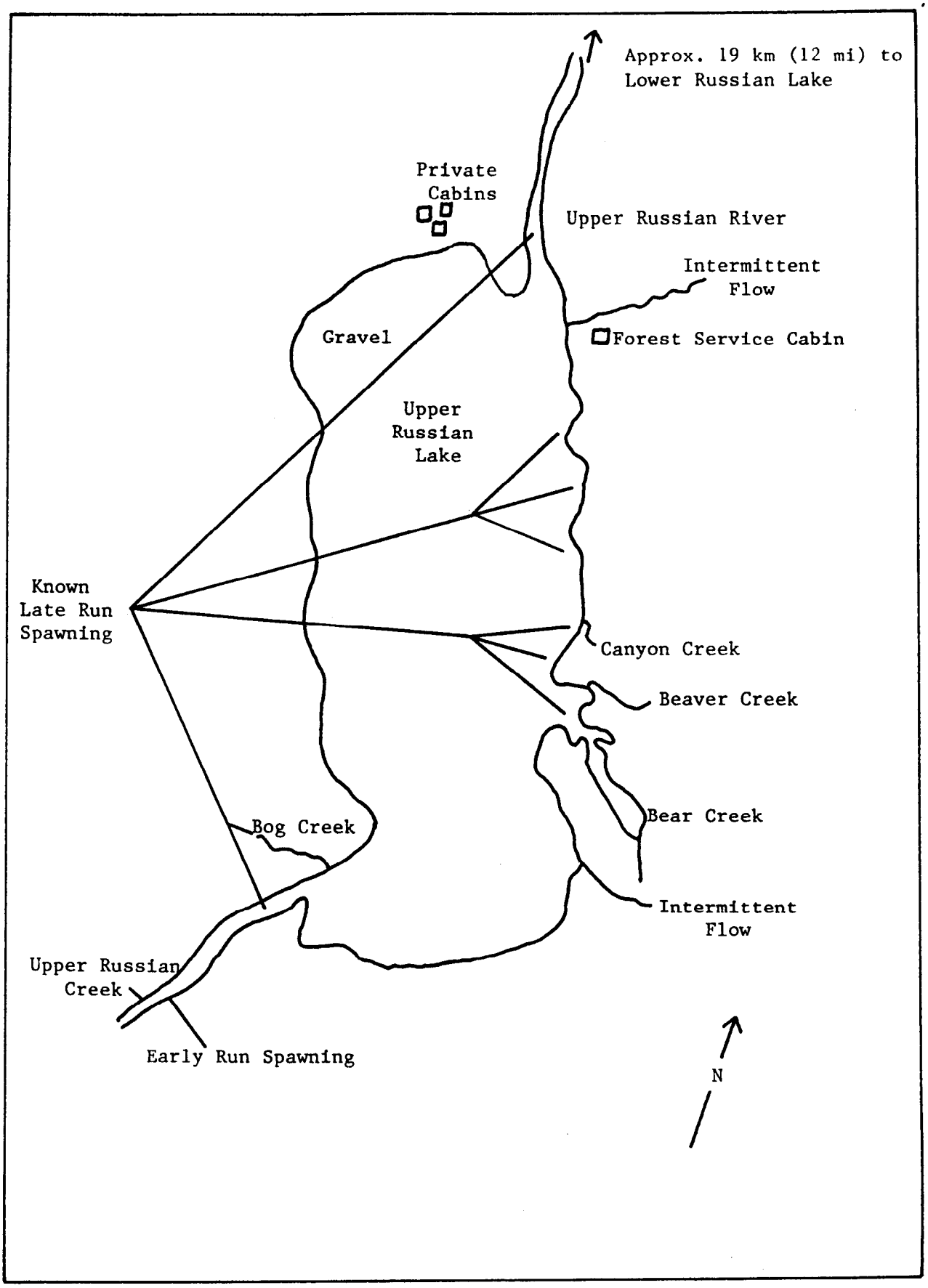

Figure 3. Schematic Diagram of Upper Russian Lake (Not to Scale).

5. To collect basic climatological data (precipitation, water and air temperature, steam discharge) during the summer at Lower Russian Lake and to determine the affect of the parameters on migrational timing of adult early and late run sockeye salmon.

6. To evaluate the effects and effectiveness of a fishpass at Russian River Falls whenever water velocity impedes sockeye salmon migration.

7. To evaluate current regulations governing this sport fishery and to provide recommendations for future management and research.

TECHNIQUES USED

The 1983 Russian River creel census was a modification of the technique described by Neuhold and Lu (1957). Sampling procedures and data analyses were identical to those outlined by Engel (1965, 1970, 1972) and Nelson (1973, 1975).

Adult escapements were enumerated by weir at the outlet of Lower Russian Lake. The present structure built in June 1975 replaced an earlier temporary weir described by Engel (1970) which had been employed since 1969. Nelson (1976) has presented a detailed description of the present structure.

Fecundities of late run sockeye salmon were determined by random sampling at Lower Russian Lake weir. Sampling technique and analyses have been described (Nelson, 1981).

Scale samples to determine the age structure of the respective runs were collected at Lower Russian Lake weir. Age designation and methods to determine the adult age structure and male to female sex ration have been presented (Nelson, 1978).

Potential egg deposition from the early run spawning escapement in Upper Russian Creek was determined applying criteria previously described (Nelson, 1976).

Water and air temperature at Lower Russian Lake weir was determined by Taylor maximum-minimum thermometer. Precipitation was ascertained by a gauge of standard manufacture. Russian River velocity was determined by Head Rod Method as previously described (Nelson, 1977). Velocity of Rondezvous Creek, tributary to Russian River above Russian River Falls, was determined in a like manner.

FINDINGS

Creel Census

As noted, Russian River sockeye salmon runs are bimodal. During most years the sport fishery is continuous as the latter segment of the early

run is present when the late run enters the fishery. This, however, did not occur in 1981, 1982 (Nelson, 1983) or 1983. In 1983 the early run migration through the fishery was complete by July 4. The late run did not arrive until July 24. No creel census was therefore conducted from July 5 through 23.

The census revealed anglers expended 31,890 man-days of effort, or 145,195 angler-hours during the fishery. Effort directed toward early and late run stocks was estimated at 18,560 and 13,330 man-days, respectively. Angler effort in 1983 was 8.1% greater than the historical mean angler participation of 29,487 man-days, but well below the effort for the previous 6 years which ranged from 51,030 to 69,510 man-days. The decrease in 1983 angler effort is attributed to the rapid migration of the early and late runs through the fishery and an emergency order closing the late run fishery for stock conservation on August 5. The late run fishery is not scheduled to close by regulation until August 20.

Based on interviews with 1,675 anglers who reported harvesting 1,364 sockeye salmon, total catch was estimated at 24,360 fish. Early and late runs contributed 8,360 and 16,000 salmon, respectively, to this harvest. The 1983 total harvest is above the historical mean harvest (23,098), but well below the harvests of the previous 6 years which ranged from 34,440 to a record 62,250. As is angler effort, catch is a reflection of run strength and the time fish are available for harvest.

Mean hourly catch rates were higher on weekdays (0.208) than on weekends (0.151) due to greater congestion on weekends which reduced angler efficiency. Seasonal catch per hour was 0.177 which is identical to the historic mean. Table 2 summarizes historical harvest, effort and catch per hour estimates since 1963.

Total weekday and weekend stream counts during the 1983 fishery averaged 205.1 and 307.6 anglers, respectively. These counts indicate crowded conditions on both weekdays and weekends. On Sunday, July 31, at 1100 hours, 592 anglers were enumerated in the "fly-fishing-only area". Although this is appreciably less than the record 1982 count of 1,012, it is significant in that 503 of the 592 anglers were concentrated at the confluence of the Kenai and Russian Rivers. Both early and late run migrated rapidly through the Russian River and fishing in this area was described as generally "poor". A paucity of fish in Russian River concentrated anglers at the confluence which created severe angler congestion in this limited area.

Sockeye salmon were available to sport anglers for 38 days in 1983. Average daily angler effort was in excess of 800 man-days. Anglers harvested an average of 641 fish daily. These data attest to the high degree of angler interest in this fishery and the relatively high efficiency of Russian River sockeye salmon anglers.

Anglers fished an average of 4.6 hours on both weekdays and weekends (Table 3). Nelson (1979) suggested the time the average angler spent on the stream was related to run strength. Sockeye salmon returns to Russian River in 1972, 1977 and 1978 through 1981 were high. Average hours fished per angler during these years was less than the historical

Table 2. Estimated Sockeye Salmon Harvest, Effort and Success Rates on Russian River, 1963-1983.

Year	Harvest			Total Effort (Man-Days)	Catch/ Hour	Census Period
	Early Run	Late Run	Total			
1963	3,670	1,390	5,060	7,880	0.190	6/08-8/15
1964	3,550	2,450	6,000	5,330	0.321	6/08-8/16
1965	10,030	2,160	12,190	9,720	0.265	6/15-8/15
1966	14,950	7,290	22,240	18,280	0.242	6/15-8/15
1967	7,240	5,720	12,960	16,960	0.141	6/10-8/15
1968	6,920	5,820	12,740	17,280	0.134	6/10-8/15
1969	5,870	1,150	7,020	14,930	0.094	6/07-8/15
1970	5,750	600	6,350	10,700	0.124	6/11-8/15*
1971	2,810	10,730	13,540	15,120	0.192	6/17-8/30*
1972	5,040	16,050	21,090	25,700	0.195	6/17-8/21
1973	6,740	8,930	15,670	30,690	0.102	6/08-8/19*
1974	6,440	8,500	14,940	21,120	0.131	6/08-7/30*
1975	1,400	8,390	9,790	16,510	0.140	6/14-8/13*
1976	3,380	13,700	17,080	26,310	0.163	6/12-8/23*
1977	20,400	27,440	47,840	69,510	0.168	6/18-8/17
1978	37,720	24,530	62,250	69,860	0.203	6/07-8/09
1979	8,400	26,830	35,230	55,000	0.136	6/09-8/20*
1980	27,220	33,490	60,710	56,330	0.243	6/13-8/20
1981	10,720	23,720	34,440	51,030	0.156	6/09-8/20
1982	34,500	10,320	44,820	51,480	0.201	6/11-8/04**
Mean	11,137	11,961	23,098	29,487	0.177	
1983	8,360	16,000	24,360	31,890	0.117	6/08-8/04**

* Census period was not continuous during these years due to emergency closures required to increase spawning escapement levels.

** Census period was not continuous during these years due to negligible fishing effort after completion of the early run and prior to the arrival of the late run.

Table 3. Difference Between Weekday and Weekend Fishing Pressure and Rates of Success at Russian River, 1964-1983.

Year	Mean Angler Counts		Catch/Hour		Mean Hours Fished	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
1964	29.6	70.6	0.444	0.209	3.3	3.9
1965	31.7	78.1	0.305	0.223	4.5	5.4
1966	53.2	143.1	0.297	0.183	4.8	5.5
1967	68.9	110.5	0.171	0.100	5.3	5.4
1968	71.5	124.9	0.153	0.107	5.3	5.8
1969	64.5	111.7	0.110	0.074	4.9	5.1
1970	83.5	127.8	0.140	0.100	4.8	4.7
1971	87.9	157.2	0.194	0.189	4.8	5.3
1972	73.3	138.5	0.203	0.187	4.0	4.4
1973	147.1	195.0	0.113	0.088	4.8	5.5
1974	123.8	144.4	0.164	0.085	4.7	5.7
1975	65.0	149.6	0.145	0.136	4.5	5.1
1976	72.5	134.4	0.165	0.161	3.5	4.5
1977	201.7	438.6	0.172	0.164	3.9	4.3
1978	264.1	425.7	0.205	0.191	3.9	4.2
1979	190.6	276.8	0.158	0.117	3.8	3.9
1980	299.1	317.8	0.270	0.210	4.2	4.7
1981	195.6	238.5	0.167	0.141	4.1	4.1
1982	256.0	423.4	0.210	0.194	4.3	4.5
Mean	125.2	195.1	0.199	0.150	4.4	4.8
1983	205.1	307.6	0.208	0.151	4.6	4.6

mean. The 1982 early run was the largest recorded and the late run one of the smallest. Anglers fished an average of fewer hours during the early run and spent a greater amount of time on the stream during the late run migration. In 1983 the early run was above average but moved rapidly through the fishery. The late run was less than average. Anglers spent a greater amount of time on the stream per day during both runs than they did during the years of high returns when fish were available for the entire season. These data therefore support the above observation in that anglers fish fewer hours when salmon are numerous as opposed to a greater number of hours when fewer fish are available for harvest.

Stream counts revealed 42.9 and 91.9% of the anglers fished the confluence of the Kenai and Russian Rivers during the early and late run, respectively. Russian River flows were low during the late run migration and limited "holding water" was available. The late run migrated rapidly through the area affording limited fishing opportunity. Additionally, this fishery was closed on August 5, prior to the majority of the fish moving upstream. These combined factors concentrated anglers at the confluence of the Kenai and Russian Rivers while providing limited fishing opportunity in the clear waters of Russian River during the late run fishery.

Anglers harvested 28.3% of the early run stock returning to Russian River and 32.0% of the late. The early run exploitation rate is relatively low in relation to the above average return of these fish. This is related to the rapid migration of early run salmon through the fishery. The late run harvest rate exceeded the historical mean by 11.7% and would have been even higher had the fishery not been closed to increase escapement levels.

Nelson (1982) indicated angler effort would be directed toward the more numerous stock rather than toward the early or late run per se. The 1983 early run was above the historical average and the late run below. The early run provided 58.2% of the fishing opportunity and the late run 41.8% (Table 4). It is therefore evident that numbers of fish available to the sport angler dictates angling effort, and that participation is independent of whether the more numerous stock is early or late run. Run timing, migrational rate and regulations pertaining to the respective runs will also influence angler participation, but numbers of sockeye salmon will be the primary parameter directing angler effort to either the early or late run (Nelson, 1983).

During the census 34 Dolly Varden, 19 rainbow trout and 1 coho salmon were creel checked. These data were not expanded as the fishery for these species occurs primarily after the sockeye salmon fishery (Nelson, 1983). No pink salmon were observed as this species arrived at Russian River after the sockeye salmon fishery was closed by emergency order and the creel census terminated.

In 1977 the Sport Fish Division initiated a Statewide Harvest Survey. It is from this survey that harvest estimates other than sockeye salmon are derived for Russian River (Nelson, 1982). Although harvest estimates for species other than sockeye salmon are not included as an objective of the

Table 4. Angler Effort Directed Toward Early and Late Run Russian River Sockeye Salmon Stocks, 1963-1983.

Year	Effort (Man-Days)*		Effort (Percent)	
	Early Run	Late Run	Early Run	Late Run
1963	5,710	2,170	72.5	27.5
1964	3,980	1,350	74.7	25.3
1965	7,750	1,970	79.7	20.3
1966	11,970	6,310	65.5	34.5
1967	11,460	5,500	67.6	32.4
1968	11,780	5,500	68.2	31.8
1969	12,290	2,640	82.3	17.7
1970	9,700	1,000	90.7	9.3
1971	6,250	8,870	41.3	58.7
1972	12,340	13,360	48.0	52.0
1973	15,220	15,470	49.6	50.4
1974	11,090	10,030	52.5	47.5
1975	5,210	11,300	31.5	68.5
1976	8,930	17,380	33.9	66.1
1977	38,200	31,310	55.0	45.0
1978	51,910	17,950	74.3	25.7
1979	25,670	29,330	46.7	53.3
1980	31,430	24,900	55.8	44.2
1981	24,780	26,250	48.6	51.4
1982	39,000	12,480	75.8	24.2
Mean	17,233	12,253	60.7	39.3
1983	18,560	13,330	58.2	41.8

* Man-day is one angler fishing for one day irrespective of the number of hours fished.

Russian River study, the results of the survey as they relate to Russian River are summarized in Table 5 to maintain the continuity of the Sport Fish Division's research and management efforts on this popular Alaskan stream.

The 1982 rainbow trout and Dolly Varden harvest declined by 47.7 and 30.1%, respectively, compared to the historical mean. The coho salmon catch was comparable to the harvest from 1977-1980 and registered a significant increase compared to the 1981 estimate of 346. The pink salmon harvest was 1,142 which is comparable to previous "even year" harvests. The Arctic grayling catch of 34 approximates the historical mean harvest for this species (50).

Nelson (1983) reviewed the Russian River rainbow trout fishery from the late 1930's to present. Available information from Federal records indicated that as early as 1940 the population was beginning to decline. Under State management several restrictive regulatory actions were promulgated in an effort to restore the population to former levels. There is no information regarding this stream's rainbow trout fishery from the early 1940's until the initiation of the Statewide Harvest Survey in 1977.

The Harvest Study revealed the catch of this species increased from 1977 through 1979 and then began to decline. A harvest of 1,077 in 1982 represents the third year of decreased catches. Reasons for the reduced harvests are not known nor is it known if a reduction in harvest equates to a declining population. Angler preference, water levels, availability of sockeye salmon, etc., undoubtedly influence the harvest of this species. A conclusion regarding the Russian River rainbow trout population must therefore be deferred until more definitive data are available.

Dolly Varden in Russian River are second in abundance only to sockeye salmon. The 1982 harvest of 1,730 is the lowest catch since 1977. As with rainbow trout, conclusions regarding the status of this species' population must await more definitive information.

Escapement

The weir at the outlet of Lower Russian Lake was operational June 10. The first early run sockeye salmon was passed on June 12, 6 days prior to the mean historic (1960-1982) arrival of June 18. Fifty percent of the early run was enumerated by July 1. Passage of this run was complete on July 25 (Table 6).

Early run spawning escapement was 21,200 fish. This is the eighth consecutive year the early run minimum spawning escapement goal of 9,000 has been exceeded (Table 7). Total early run return (harvest plus escapement) was 29,560.

Late run fish began to pass the weir on July 26, 8 days later than their average annual arrival date. Fifty percent of the migration had passed the structure by August 6. Late run migration was complete when the weir was removed on September 6.

Table 5. Estimated Russian River Harvest of Rainbow Trout, Dolly Varden, Coho Salmon, Pink Salmon and Grayling as Determined by Alaska Statewide Harvest Survey, 1977-1982.

Year	Species				
	Rainbow Trout	Dolly Varden	Coho Salmon	Pink Salmon	Grayling
1977	769	914	1,472	37	37
1978	2,423	2,588	1,466	1,300	18
1979	3,109	3,718	1,098	0	9
1980	2,566	2,256	1,025	930	69
1981	1,437	2,905	346	0	119
Mean	2,061	2,476	1,081	453	50
1982	1,077	1,730	1,275	1,142	34

Table 6. Arrival Date, Date Fifty Percent of the Escapement Had Passed Russian River Weir/Counting Tower and Termination date of Early and Late Russian River Sockeye Salmon Runs, 1960-1983*.

Year	Early Run			Late Run		
	Arrival at Weir/ Counting Tower	Date 50% Passed	Date Run Ended	Arrival at Weir/ Counting Tower	Date 50% Passed	Date Run Ended**
1960	June 19	June 26	July 15	July 16	Aug. 1	Aug. 12
1961	June 21	June 28	July 15	July 16	July 31	Aug. 28
1962	June 18	July 4	July 15	July 16	July 30	Aug. 31
1963	June 18	July 1	July 12	July 16	July 31	Aug. 23
1964	June 20	July 7	July 15	July 16	July 30	Aug. 15
1965	June 22	July 4	July 15	July 16	Aug. 5	Aug. 15
1966	June 20	June 29	July 15	July 19	July 30	Aug. 17
1967	June 20	June 28	July 15	July 19	Aug. 2	Aug. 18
1968	June 25	June 29	July 13	July 19	July 31	Aug. 14
1969	...	...	...	July 16	Aug. 2	Aug. 18
1970	June 17	July 5	July 15	July 16	Aug. 7	Aug. 23
1972	June 24	July 5	July 29	July 30	Aug. 5	Aug. 28
1973	June 21	July 6	July 15	July 16	Aug. 1	Aug. 30
1974	June 14	July 1	July 21	July 22	Aug. 7	Aug. 27
1975	June 25	July 6	July 27	July 21	Aug. 6	Sept. 1
1976	June 17	June 30	July 16	July 17	Aug. 2	Sept. 1
1978	June 10	July 2	July 24	July 2	July 30	Sept. 1
1979	June 8	June 27	July 15	July 16	July 29	Sept. 2
1980	June 14	June 29	July 20	July 21	July 30	Sept. 6
1981	June 12	June 25	July 17	July 18	July 28	Sept. 6
1982	June 11	July 3	July 23	July 24	Aug. 4	Sept. 14
1960-82 Mean	June 18	July 1	July 18	July 18	Aug. 2	Aug. 26

Table 6 (cont.). Arrival Date, Date Fifty Percent of the Escapement Had Passed Russian River Weir/Counting Tower and Termination date of Early and Late Russian River Sockeye Salmon Runs, 1960-1983*.

	Early Run			Late Run		
Year	Arrival at Weir/ Counting Tower	Date 50% Passed	Date Run Ended	Arrival at Weir/ Counting Tower	Date 50% Passed	Date Run Ended**
1969-1982 Mean***	June 16	July 2	July 20	July 18	Aug. 2	Aug. 31
1983	June 12	July 1	July 25	July 26	Aug. 6	Sept. 6

* Data from 1971 and 1977 deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Date run ended or escapement enumeration discontinued for the season.

*** Years of weir operation.

Table 7. Russian River Sockeye Salmon Escapement and Harvest Rates for Early and Late Runs, 1963-1983.

Year	Escapement*			Percentage of Run Caught by the Sport Fishery		
	Early Run	Late Run	Total	Early Run	Late Run	Total
1963	14,380	51,120	65,500	20.3	2.0	7.2
1964	12,700	46,930	59,630	21.8	5.0	9.6
1965	21,710	21,820	43,330	31.8	9.0	21.6
1966	16,660	34,430	51,090	47.3	17.5	30.3
1967	13,710	49,480	63,190	34.6	10.3	17.0
1968	9,200	48,880	58,080	42.9	10.6	18.0
1969	5,000	28,920	33,920	54.0	3.8	17.1
1970	5,450	28,200	33,650	51.3	2.1	15.9
1971	2,650	54,430	57,080	51.5	16.4	19.2
1972	9,270	79,000	88,270	35.2	16.8	19.3
1973	13,120	24,970	38,090	33.9	26.3	29.1
1974	13,150	24,650	37,800	32.9	25.6	28.3
1975	5,640	31,970	37,610	19.9	20.8	20.7
1976	14,700	31,950	46,650	18.7	30.0	26.8
1977	16,070	21,410	37,480	55.9	56.2	56.1
1978	34,150	34,230	68,380	52.5	41.7	47.7
1979	19,700	87,920	107,620	29.9	23.4	24.7
1980	28,670	83,980	112,650	48.7	29.7	35.0
1981	21,140	44,530	65,670	33.6	34.7	34.4
1982	56,080	30,630	86,710	38.1	25.2	34.1
Mean	16,657	42,973	59,630	37.7	20.3	25.6
1983	21,200	34,000	55,200	28.3	32.0	30.6

* Escapement past weir. Commercial harvest and fish spawning downstream from Russian River weir are deleted.

Escapement of late run fish to Upper Russian Lake drainage was 34,000. An additional 44,000 late run fish spawned below Russian River Falls. This is the second highest escapement in this area being surpassed only in 1982 (45,000). Total late run 1983 spawning escapement was therefore 78,000 or 49.6% above the historical total escapement of 52,126.

Total late run return (harvest and total escapement) was 94,000. This is well below the 1980 record late run return of 120,690, but exceeds the mean historical return by 27,194 or 40.7% (Table 8).

Fifty-two chinook salmon were enumerated at Russian River weir in 1983. An additional 130 chinook salmon spawned in lower Russian River. Total spawning escapement of 182 is 21.5% below the historical mean of 232. Coho salmon escapement was 475. This is the lowest escapement of this species since 1969. Russian River chinook and coho salmon escapements are summarized in Table 9.

Relationship of Jacks to Adults

Jack (precocial male) sockeye salmon are generally not associated with the early sockeye salmon run. Prior to 1983, jacks were observed during only 5 of 12 years and then not in large numbers (Nelson, 1982). In 1983, 98 jacks were enumerated. This is the highest number of jacks recorded during the early run migration. Jacks are more numerous during the late run and comprise 0.2 to 8.8% of the total return to Russian River. In 1983, 4,360 jacks were enumerated comprising 8.7% of the total late run return to Upper Russian Lake drainage (Table 10).

Nelson (1977) suggested a relationship may exist between numbers of jacks in the late run and the magnitude of the late run return the succeeding year. This author (Nelson, 1982) concluded a relatively small jack return in a given year may be indicative of a less than average return the following year and that the converse may also be true. Historical data indicate this premise is true if applied as a generalization, but that exceptions do occur (Nelson, 1983).

The 1981 jack escapement of 2,634 was one of the largest recorded. The 1982 late run return above Russian River Falls would therefore have been expected to be above average. This did not occur as the 1982 return was a relatively low 40,950. The 1982 jack escapement was 1,777 which is above the average of 1,375. The 1983 total return of 50,000 was below average. These data therefore invalidate the premise that numbers of jacks in the preceding year are an annual indicator of run strength to Russian River.

Foerster (1968) has also noted that age class 1.2 sockeye salmon (jacks) "in some areas at least, appear in abundance in the year preceding a 'big' year." At Russian River this may only be true if the total return, to include late run fish harvested by the commercial fishery, are included in determining the total late run return.

The number of commercial fishing periods allocated to the Cook Inlet commercial fishery is dependent on total numbers of sockeye salmon returning to upper Cook Inlet. In 1982 and 1983 additional fishing time

Table 8. Late Run Russian River Sockeye Salmon Total Return and Escapement Enumerated Above and Below Russian River Falls, 1968-1983.

Year	Escapement Above Falls	Escapement Below Falls	Total Escapement	Percent of Escapement Below Falls	Sport Harvest	Total Return
1968	48,800	4,200	53,000	7.9	5,820	58,820
1969	28,920	1,100	30,020	3.7	1,150	31,170
1970	28,200	220	28,420	0.8	600	29,020
1971	54,430	10,000	64,430	15.5	10,730	75,160
1972	79,000	6,000	85,000	7.1	16,050	101,050
1973	24,970	6,690	31,660	21.1	8,930	40,590
1974	24,650	2,210	26,860	8.2	8,500	35,360
1975	31,970	690	32,660	2.1	8,390	41,050
1976	31,950	3,470	35,420	9.8	13,700	49,120
1977	21,410	17,090	38,500	44.4	27,440	65,940
1978	34,230	18,330	52,560	34.9	24,530	77,090
1979	87,920	3,920	91,840	4.3	26,830	118,670
1980	83,980	3,220	87,200	4.0	33,490	120,690
1981	44,530	4,160	48,690	8.5	23,720	72,410
1982	30,630	45,000	75,630	59.5	10,320	85,950
Mean	43,706	8,420	52,126	15.5	14,680	66,806
1983	34,000	44,000	78,000	56.4	16,000	94,000

Table 9. Estimated Coho and Chinook Salmon Spawning Escapements in Russian River Drainage, 1953-1983.

Year	Weir/Counting Tower Escapements		Lower River Escapement*	Total Escapement	
	Chinook	Coho	Chinook	Chinook	Coho
1953			85**		
1954			87**		
1955			42**		
1956			40**		
1957			44**		
1958			98**		
1966			182		
1967			126		
1968	56		63	119	
1969	119	70	31	150	70
1970	240	957	125	365	957
1971	21	839	149	170	839
1972	172	666	108	280	666
1973	243	200	104	347	200
1974	124	1,508	59	183	1,508
1975	102	4,000	32	134	4,000
1976	145	1,791	155	300	1,791
1977	37	1,884	145	182	1,884
1978	253	1,570	165	418	1,570
1979	280	2,400	82	362	2,400
1980	185	3,189	65	250	3,189
1981	30	4,679	91	121	4,679
1982	68	2,291	35	103	2,291
Mean	138	1,860	92	232	1,860
1983	52	475	130	182	475

* Coho salmon do not spawn in Lower Russian River.
** U.S. Fish and Wildlife Service data.

Table 10. Late Run Russian River Sockeye Salmon Harvest, Escapement and Returning Jacks, 1969-1983.

Year	Escapement	Harvest	Total Return*	Number of Jacks	Percent of Total Return
1969	28,920	1,150	30,070	352	1.2
1970	28,200	600	28,800	2,542	8.8
1971	54,430	10,730	65,160**	1,429	2.2
1972	79,000	16,050	95,050	160	0.2
1973	24,970	8,930	33,900	332	1.0
1974	24,650	8,500	33,150	1,008	3.0
1975	31,970	8,390	40,360	1,788	4.4
1976	31,950	13,700	45,650	1,204	2.6
1977	21,410	27,440	48,850	537	1.1
1978	34,230	24,530	58,760	2,874	4.9
1979	87,920	26,830	114,750	1,476	1.3
1980	83,980	33,490	117,470	1,533	1.3
1981	44,530	23,720	68,250	2,634	3.9
1982	30,630	10,320	40,950	1,777	4.3
Mean	43,342	15,313	58,655	1,403	2.9
1983	34,000	16,000	50,000	4,360	8.7

* Excludes commercial harvest and late run sockeye salmon which spawn below Russian River Falls.

** Excludes an estimated 10,000 late run sockeye salmon which perished below Russian River Falls due to a velocity barrier.

was permitted as the return to the area was high. An above average percentage of late run Russian River adult fish may have been harvested leaving few fish to return to their natal stream. During years of low sockeye salmon returns to upper Cook Inlet, commercial fishing time is reduced. This may result in a relatively low commercial harvest of Russian River fish and a correspondingly high return to Russian River. Jacks are not affected by the commercial fishery as they pass through the gill nets designed to capture larger adults (Nelson, 1982).

Variable adult annual harvest rates in the Cook Inlet commercial fishery would therefore create a situation whereby the "jack to succeeding year adult" relationship would display annual variation. If there was no commercial harvest or that fishery caught jacks in a constant proportion to adults, a more consistent and discernible "jack to succeeding year adult" relationship would be evident.

Table 11 compares the migrational timing of adults to late run jacks. Fifty percent of the adults may be expected to pass the weir by August 2, while 50% of the jack escapement is not enumerated until August 15, 13 days later than the adults. In 1982 and 1983 the timing disparity was 15 and 11 days, respectively. In 1980 the differential was 20 days and in 1981, 25. From 1970-1979 it ranged from 3 to 17 days.

This timing differential may be a genetic trait, related to environmental parameters or a combination thereof (Nelson, 1976). This author indicated water velocities through Russian River Falls generally decrease during the latter part of the late run migration and may facilitate the movement of smaller jacks through the falls. Larger adults may be more readily capable of negotiating the falls at greater velocities and therefore arrive earlier at the weir. Russian River was atypically high in 1980 and 1981 which may account for the above average timing differential in those years. Water velocities were not excessive in 1982 and were below the historical average in 1983. The timing differential of 15 days in 1982 approximates the mean, while the 11-day differential in 1983 is what might be expected considering the reduced velocity.

Migrational Rates in the Kenai River

Migrational rates of Russian River stocks within the Kenai River are limited to isolated tagging studies and a comparison of sonar counts to escapements enumerated at Russian River weir. Tagging studies have been reviewed (Nelson, 1977).

A sonar counter is located 1.6 km (1 mi) below the Kenai River Bridge in Soldotna. This enumeration device is operated by the Commercial Fish Division of the Alaska Department of Fish and Game. Its primary function is to ascertain the spawning escapement of late run Kenai River sockeye salmon, but it was employed in 1978, 1979 and 1981 to determine the magnitude of the early run Kenai River sockeye salmon return. Available data indicate this stock is of Russian River origin. Comparing sonar counts to weir escapement data, Nelson (1982) concluded early run Russian River fish migrated 3.2 km (2 mi) to 5.1 km (3.2 mi) per day.

Table 11. Migrational Timing of the Late Run Russian River Sockeye Salmon Jack Escapement Compared to the Migrational Timing of the Adult Escapement, 1970-1983*.

Year	Jack Escapement	Date 50% Passed Weir	Adult Escapement**	Date 50% Passed Weir	Timing Differential (Days)
1970	2,542	Aug. 10	25,658	Aug. 7	3
1972	160	Aug. 10	78,840	Aug. 4	6
1973	332	Aug. 6	24,638	July 31	6
1974	1,008	Aug. 12	23,642	Aug. 6	6
1975	1,788	Aug. 16	30,182	Aug. 5	11
1976	1,204	Aug. 18	30,746	Aug. 2	16
1978	2,874	Aug. 18	31,356	Aug. 2	16
1979	1,476	Aug. 15	86,444	July 29	17
1980	1,533	Aug. 19	82,447	July 30	20
1981	2,634	Aug. 22	41,896	July 28	25
1982	1,777	Aug. 19	28,853	Aug. 4	15
Mean	1,575	Aug. 15	44,064	Aug. 2	13
1983	4,360	Aug. 16	29,640	Aug. 5	11

* Data from 1971 and 1977 deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Escapement past the weir only. Sockeye salmon spawning below Russian River Falls are not considered.

Late run sockeye salmon sonar counts in the Kenai River, Russian River late run escapements and travel time between sonar counter and Russian River weir are presented in Table 12. Elapsed time between these two points from 1969-1982 ranged from 10 and 34 days averaging 14.7. Eliminating the 1969 and 1974 extremes, which appear to be atypical, decreases this range to between 10 and 15 days. The late run migrational rate would therefore be 6.2 km (3.8 mi) to 9.3 km (5.8 mi) per day. It required 18 days for late run fish in 1983 to traverse the 93.5 km (58 mi) between sonar site and weir or 5.1 km (3.2 mi) per day. Late run fish in most years therefore migrate more rapidly through the Kenai River than do early run stocks. Reason(s) for these differing migrational rates are not known.

A comparison of sonar data and total Russian River late run return (harvest plus escapement) provides an estimate of Russian River's contribution to the Kenai River sockeye salmon escapement. Table 13 indicates this contribution ranges from 8.7 to 66.9%. In 1983, Russian River accounted for 14.9% of the late run Kenai River sockeye salmon escapement.

Russian River Falls and Fish Pass

The fish pass at Russian River Falls was constructed during the winter of 1978-79 and employed for the first time on a limited basis during the 1979 season. It was concluded, at the time, that given an option at normal water flows, sockeye salmon would ascend the falls rather than utilize the fish pass (Nelson, 1980). This same author (1981) noted that during high water in 1980 mean passage rate through the fish pass was 510 fish/hour and that the structure was operating as designed. He also indicated operation or inoperation of the fish pass during high water years could be used to increase or decrease the rate of migration. The structure could therefore be considered a management tool as the migrational rate of the stocks affect the degree to which the recreational angler is capable of exploiting the resource.

Figure 4 indicates Russian River discharge was below historic flow rates during all of the early and most of the late run migration. Discharge rates did not exceed 300 cfs in 1983. Nelson (1978) indicated velocities which approach 400 cfs present a barrier to sockeye salmon migration. Use of the fish pass to provide access to the Upper Russian Lake spawning grounds was not required in 1983. As salmon exclusively used their preferred migratory route through the falls, the structure could not be used as a management tool to increase or decrease migratory rates during the 1983 season.

Management of the 1983 Fishery

Early Run:

The early run arrived at the confluence of the Kenai and Russian Rivers on June 8. Catch rates were low during the first 12 days of the fishery averaging 0.089 fish per hour. Observation revealed the majority of the harvest and angler effort was concentrated at the confluence. The "sanctuary area" contained a large number of sockeye salmon, but few fish

Table 12. Kenai River Sockeye Salmon Sonar Counts Compared to Russian River Late Run Sockeye Salmon Escapements and Period of Travel Between Sonar Site and Russian River Weir, 1968-1982*.

Year	Sonar Count	Date 50% Passed	Russian River Escapement**	Date 50% Passed	Sonar to Weir (Days)
1968	88,000	July 19	48,800	July 30	11
1969	53,000	June 30	28,920	Aug. 2	34
1970	68,000	July 25	28,200	Aug. 6	13
1972	335,000	July 24	79,000	Aug. 4	12
1973	368,000	July 22	24,970	July 31	10
1974	157,000	July 17	24,650	Aug. 6	23
1975	143,000	July 24	31,970	Aug. 5	13
1976	381,000	July 20	31,950	Aug. 2	13
1978	399,000	July 18	34,230	July 30	12
1979	322,000	July 19	87,920	July 29	10
1980	464,000	July 19	83,980	July 30	11
1981	408,000	July 14	44,530	July 28	14
1982	620,000	July 21	30,630	Aug. 4	15
Mean	292,769	July 19	44,596	Aug. 4	14.7
1983	630,000	July 19	34,000	Aug. 6	18

* Data from 1971 and 1977 deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Escapement past the weir only. Sockeye salmon spawning below Russian River Falls are not considered.

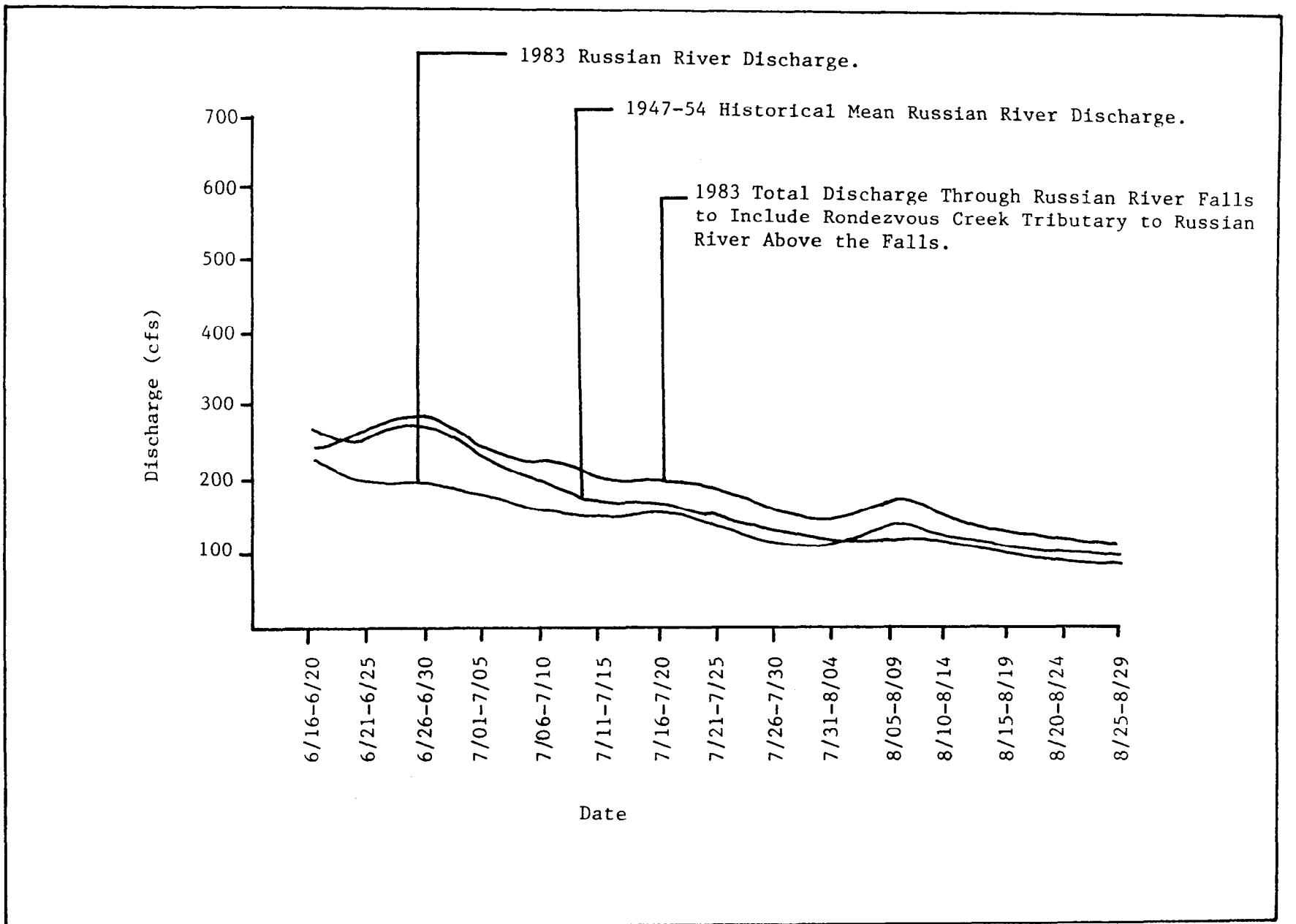

Figure 4. Mean (Eight Year) Russian River Discharge Rates by Five Day Mean Recorded by United States Geological Survey From 1947 Through 1954 Compared to 1983 Discharge Rates.

were in the clear water of lower Russian River. Similarly, there was no concentration of fish in Russian River Falls. Spawning escapement as of June 19 was only 760.

On June 20, sockeye salmon holding in the "sanctuary area" accelerated their migrational rate. In the 11-day period of June 20 through June 30, the escapement increased by a factor of nine (1,132 to 10,355). In the next 10 days more than 10,000 fish moved upstream, and on July 10 the escapement exceeded 20,000. It decreased after this date and the final escapement of 21,200 was achieved July 25. The minimum escapement goal of 9,000 and the historical mean spawning escapement of 16,657 were therefore exceeded.

Anglers did not benefit from the above average return of early run fish. Catch rates were above 0.100 fish per hour during only 4 days (June 20-23) of the fishery. The early run fishery concluded on July 4 when catch rates fell to 0.028.

Failure of the recreational angler to harvest greater numbers of early run fish is directly related to the en masse movement of these fish from the safety of the "sanctuary area" to the safety of Russian River Falls. They did not "hold" in lower Russian River because of low water levels. The early run was therefore available to the sport angler for only an abbreviated period as they passed through the area below the ferry crossing. This rapid migration and failure of the stock to "hold" in lower Russian River not only reduced angler efficiency, but negated the options available to the Department of Fish and Game to increase harvest levels.

The "sanctuary area" is opened when the minimum escapement of 9,000 is projected. In 1983 this figure could not be projected with certainty until June 27. The fish, however, were moving so rapidly at this time that it was evident the fishery would be abbreviated and end in early July. Opening the "sanctuary area" after June 27 would have resulted in a limited increase in harvest as the fish would remain in the area only a few additional days. The credibility of the Department of Fish and Game would also have been questioned as an emergency opening of this nature implies large numbers of fish are available for an extended period of time. As early run fish would have been available for only 3 to 5 days, the "sanctuary area" remained closed during the 1983 early run migration.

Late Run:

The late run entered the recreational fishery on July 24. Observation and creel census data revealed high catch rates and angler effort at the confluence and correspondingly low catch rates and angler effort in lower Russian River. Few late run fish were observed in Russian River Falls and escapement levels were below historic passage rates. Observation indicated a relatively high but unknown percentage of those fish contributing to the confluence catches were a segment of the late run which spawn below the falls rather than fish which spawn in Upper Russian Lake drainage. These observations are similar to those recorded by Nelson (1983) during the 1982 late run fishery.

Table 13. Kenai River Sockeye Salmon Sonar Counts, Total Late Run Russian River Sockeye Salmon Return and Percent of the Kenai River Late Run Sockeye Salmon Escapement to Enter Russian River, 1968-1983*.

Year	Sockeye Salmon Sonar Count	Total Late Run Russian River Return**	Percent Kenai Run To Russian River
1968	88,000	58,820	66.8
1969	53,000	31,170	58.8
1970	68,000	29,020	42.7
1972	335,000	101,050	30.2
1973	368,000	40,590	11.0
1974	157,000	35,360	22.5
1975	143,000	41,050	28.7
1976	381,000	49,120	12.9
1977	757,000	65,940	8.7
1978	399,000	77,090	19.3
1979	322,000	118,670	36.9
1980	464,000	120,690	26.0
1981	408,000	72,410	17.7
1982	620,000	85,950	13.9
Mean	325,929	66,209	28.3
1983	630,000	94,000	14.9

* Sonar data from 1971 deleted due to equipment malfunction.

** Total late run Russian River return includes escapement past weir, sport harvest and fish spawning below Russian River Falls.

On August 3, escapement was a relatively low 7,930, although there were an additional 8,000 to 9,000 fish below the weir. It was evident that without conservation measures the minimum spawning escapement of 30,000 would not be achieved. The fishery was therefore closed on August 5 for the remainder of 1983.

During the abbreviated 12-day fishery, 13,330 man-days were expended to harvest 16,000 late run fish. Angling effort and harvest were exceptionally high averaging over 1,000 man-days of effort and 1,333 fish harvested for each day of fishing. Observation indicates that no more than 75% of the harvest was comprised of that stock which spawns in Upper Russian Lake drainage.

In deciding to close Russian River to the taking of sockeye salmon, fisheries managers were aware of the marked similarities between the 1982 and 1983 fisheries.

1. In both years the fish entered the fishery on July 24.

2. In both years the decision to close the fishery was made August 3 and implemented on August 5.

3. Total fishing time in 1982 and 1983 was 12 days or 44.4% of the scheduled season which closes by regulation August 20.

4. Final escapement in 1982 was 30,630. Due to the marked similarities between 1982 and 1983, it was assumed final 1983 escapement would also approximate 30,000.

To provide further protection to late run Russian River stocks, additional sport and commercial fishing emergency closures were issued. The entire Kenai River was closed to the taking of sockeye salmon on August 6. That portion of the river below Skilak Lake was reopened on August 10 after the majority of the run was believed to have passed through to the upper Kenai River drainage. The upper drainage, to include Russian River, remained closed. The Kenai Peninsula east side commercial set gill net fishery was closed during the regularly scheduled 12-hour period on Friday, August 5. The Monday, August 8, commercial period was delayed until Wednesday, August 10. By August 10 it was believed virtually all remaining Russian River sockeye salmon would have entered the Kenai River.

The contribution of the sport and commercial closures toward achieving the final late run Russian River escapement of 34,000 is difficult to assess. At the time of closure, the Russian River sport fishery was harvesting 1,333 sockeye salmon daily. It is evident that without closure of this fishery the escapement would not have been achieved.

As of August 6, the Kenai River sockeye salmon escapement was 615,860. By this date many of these fish had entered tributary spawning streams which receive virtually no angling pressure. Many of the remaining sockeye salmon in the Kenai River had begun to assume spawning coloration and were no longer acceptable to the majority of anglers. Angler effort

in the Kenai River was therefore relatively low. It is concluded closure of the Kenai River had a minimal effect on the Russian River escapement.

On August 1 and 10, the east side Kenai Peninsula set gill net fishery harvested 26,219 and 5,663 sockeye salmon, respectively. It is assumed that had fishing not been curtailed on August 5, harvest would have approximated the mean catch of the period prior (26,219) and the period after (5,663) that date or 15,941 sockeye salmon. Seventy-five percent of these fish are assumed to be of Kenai River origin (Paul Ruesch, Commercial Fish Area Biologist, Alaska Department of Fish and Game, Soldotna, October 11, 1983, pers. comm.). Comparing Russian River return to Upper Russian Lake drainage to Kenai River escapements enumerated by sonar counter indicates approximately 7.3% of the sockeye salmon entering the Kenai River at this time were destined for the Upper Russian Lake spawning grounds. Curtailment of the commercial fishery on August 5 therefore contributed an estimated 873 fish to the late Russian River escapement.

Escapement Goals and Management Concerns

Escapement goals for Russian River stocks were not established until the early 1970's. A management report to the Alaska Board of Fisheries in 1971 recommended a minimum early spawning escapement of 8,500. The same report indicated that if the projected late run escapement was less than 35,000, the sport fishery would be managed so as to harvest not more than 10% of that stock.

Escapement goals for this river were more clearly defined in the "Kenai-Russian River Sockeye Salmon Management Plan" in 1975. This plan raised the early run goal to 9,000 and set the late run goal at 30,000. Both escapement goals were the minimum number of spawners for the respective runs. No maximum numbers are discussed. These goals are presently in effect and were adopted as a regulation by the Alaska Board of Fisheries as "5 AAC 21.361 RUSSIAN RIVER SOCKEYE SALMON MANAGEMENT PLAN".

To achieve these minimum goals the Russian River sport fishery has been closed on 19 occasions since 1969. Initially, these closures were directed toward conservation of early run stocks. In the mid-1970's early run returns began to increase. Correspondingly, the late run returns in some years declined. Five emergency closures affecting the late run have been required for stock conservation since 1975.

Early Run Escapement Goal:

Minimum escapement goals adopted by the Alaska Board of Fisheries were recommended by the Sport Fish Division. Minimum early run goal recommended (9,000) was determined by analysis of available spawning area and historic escapement levels.

A literature review (Burgner et al. 1969; Foerster, 1968; Mathisen, 1955) revealed a female sockeye salmon required approximately 2.62 M^2 of spawning gravel. Dividing this figure into the estimated spawning area of Upper Russian Creek and assuming a male to female ratio of 1:1 indicated the stream could accommodate about 9,000 early run fish. The

mean early run escapement from 1963-1975 was 10,895. The relatively close agreement of these two figures lead to adoption of the minimum early run escapement goal of 9,000.

Early run return per spawner has been variable ranging from 0.2 to 10.6. Comparing spawning escapement to numbers of returning early run fish indicates this variation is independent of the numbers of fish in the spawning escapement. It is believed this variability is related to stream conditions (flooding, low water, etc.) during the spawning and incubation period. Early run production is in large part believed to be "spawning area limited".

Production figures are available for the early run for parent year escapements which range from 2,640 to 21,710 fish. In the single year when the parent year escapement exceeded 20,000, the run failed to reproduce itself. Although these limited data are not definitive, they do suggest the desired escapement level for this stock is less than 20,000 sockeye salmon. During the last cycle (1978-83) early run escapements have ranged from 19,700 to 56,080 with a mean of 50,166. If the escapements from the last cycle produce a minimal return, it will definitely indicate that "more is not necessarily better" when "more" refers to early run escapements.

Conversely, escapements of less than 5,000 early run fish would have to produce at least five fish for each fish in the spawning escapement if sufficient early run sockeye salmon were to be available for the recreational fishery. Although a return rate of 5:1 has occurred, the mean early run return spawner is a relatively low 2.6:1. The minimum escapement goal of 9,000 early run sockeye salmon is therefore a reasonable figure based on available data.

Late Run Escapement Goal:

When the minimum goal for the late run was established in 1975, biological data regarding this stock's early life history were limited and the contribution this run made to the Cook Inlet commercial fishery was not known. It was known that these fish spawn primarily in Upper Russian Lake and that secondary spawning included the inlet, outlet and other minor streams tributary to Upper Russian Lake. Data regarding M^2 of spawning gravel were not available, but as the majority of the spawning occurs in the lake, available spawning area was assumed to be extensive. Assuming sufficient spawning area, late run freshwater production was assumed to be "rearing area limited".

In the absence of spawning area and commercial harvest data, the late run minimum escapement goal was developed solely through analysis of escapement data. Through 1975 the mean late run escapement was 40,370. In 5 of the 13 years examined, escapements were less than 30,000; in 2 years, 30,000-40,000; in 3 years, 40,000-50,000; and exceeded 50,000 late run fish in 3 years. A minimum escapement of 30,000 was therefore achieved in 8 of 13 years prior to 1976. Based on these data a minimum late run escapement of 30,000 appeared reasonable with an escapement approximating the historical mean (40,370) being desirable.

Commercial Harvest, Exploitation Rates and Production:

Early run sockeye salmon enter the recreational fishery at Russian river as early as June 5. In most years this run has passed through the fishery by July 10. The Cook Inlet commercial fishery does not open until late June. Applying the distance and travel time discussed previously in this report, it is concluded the majority of the early run has entered the Kenai River prior to commencement of the commercial fishery. The commercial harvest of early run Russian River sockeye salmon is therefore negligible.

Late run Russian River sockeye salmon are exploited by the commercial fishery. Recent stock separation techniques employing scale analysis permit the apportionment of the Cook Inlet commercial catch to the major systems of Kenai (to include Russian River), Kasilof, Susitna and Crescent River drainages (Ken Tarbox, Research Biologist, Commercial Fish Division, Alaska Department of Fish and Game, Soldotna, pers. comm.). The Kenai River's contribution to the commercial fishery is now known, as is the spawning escapement from sonar enumeration.

A tag and recovery program conducted by the Commercial Fish Division in 1983 indicates late run Russian River fish are randomly distributed in Cook Inlet with Kenai River and other sockeye salmon stocks. It is assumed the exploitation rate of Kenai and Russian River stocks are identical. A knowledge of the Kenai and Russian River escapement permits generation of catch, total return and production per spawner data for both rivers. Harvest of late run Russian River stocks by commercial and sport fisheries is presented in Table 14.

Table 14 reveals the commercial harvest of late run Russian River fish has ranged from 43,850 (1973) to 267,680 (1978) with a 1972-1982 mean of 119,090. The estimated 1983 harvest was a record 312,320. The sport harvest at Russian River for this same period has ranged from 8,390 in 1975 to 27,440 in 1977. The 1983 harvest of 16,000 was below the historical mean of 18,355. In an average year the commercial fishery harvests an estimated 85.8% of the total catch of Russian River late run fish with the remaining 14.2% of the catch taken by the sport fishery.

Table 15 presents the percentage of late run Russian River sockeye salmon harvested by commercial and sport interests. Historically, the commercial fishery has harvested 64.3% of the total return and the sport fishery 10.5% for a combined mean exploitation rate of 74.8%. The exploitation rate for this stock has ranged from 63.1 to 90.6%.

A comparison of Kenai and Russian River total return and exploitation rates is presented in Table 16. The average exploitation rate of late run Kenai river sockeye salmon is 67.6%. These fish are harvested by the commercial fishery and a relatively minor sport fishery in the Kenai River. The average exploitation of the late run Russian River stock is 74.7%. These fish are harvested by the commercial fishery, a relatively minor Kenai River sport fishery and at Russian River by the most intense sport fishery in Alaska. Exploitation of late run Russian River sockeye salmon will therefore always be above that rate at which Kenai River fish

Table 14. Harvest of Late Run Russian River Sockeye Salmon Stocks by Commercial and Recreational Fisheries, 1972-1983.

Year	Commercial Harvest	Sport Harvest	Total Harvest	Percent of Harvest by Commercial Fishery	Percent of Harvest by Sport Fishery
1972	144,370	16,050	160,420	90.0	10.0
1973	43,850	8,930	52,780	83.1	16.9
1974	54,320	8,500	62,820	86.5	13.5
1975	89,410	8,390	97,800	91.4	8.6
1976	107,020	13,700	120,720	88.7	11.3
1977	88,750	27,440	116,190	76.4	23.6
1978	267,680	24,530	292,210	91.6	8.4
1979	123,320	26,830	150,150	82.1	17.9
1980	128,800	33,490	162,290	79.4	20.6
1981	96,600	23,720	120,320	80.3	19.7
1982*	165,870	10,320	176,190	94.1	5.9
Mean	119,090	18,355	137,445	85.8	14.2
1983*	312,320	16,000	328,320	95.1	4.9

*Data for these years are preliminary.

Table 15. Percentage of Late Run Russian River Sockeye Salmon Harvested by Commercial and Sport Fisheries, 1972-1983.

Year	Commercial and Sport Harvest	Escapement	Total Return	Percent Harvested		Combined Percent Harvested
				Commercial Fishery	Sport Fishery	
1972	160,420	79,000	239,420	60.3	6.7	67.0
1973	52,780	24,970	77,750	56.4	11.5	67.9
1974	62,820	24,650	87,470	62.1	9.7	71.8
1975	97,800	31,970	129,770	68.9	6.5	75.4
1976	120,720	31,950	152,670	70.1	9.0	79.1
1977	116,190	21,410	137,600	64.5	19.9	84.4
1978	292,210	34,230	326,440	82.0	7.5	89.5
1979	150,150	87,920	238,070	51.8	11.3	63.1
1980	162,290	83,980	246,270	52.3	13.6	65.9
1981	120,320	44,530	164,850	58.6	14.4	73.0
1982*	176,190	30,630	206,820	80.2	5.0	85.2
Mean	137,445	45,021	182,466	64.3	10.5	74.8
1983*	328,320	34,000	362,320	86.2	4.4	90.6

* Data for these years are preliminary.

Table 16. Exploitation Rate of Late Run Kenai and Russian River Sockeye Salmon, 1972-1983.

Year	Total Return*		Commercial Sport Harvest		Exploitation Rate	
	Kenai R.	Russian R.	Kenai R.**	Russian R.	Kenai R.	Russian R.
1972	800,070	239,420	498,100	160,420	62.3	67.0
1973	841,910	77,750	483,800	52,780	57.5	67.9
1974	433,180	87,470	288,710	62,820	66.6	71.8
1975	462,490	129,770	333,990	97,800	72.2	75.4
1976	1,287,820	152,670	934,040	120,720	72.6	79.1
1977	2,014,820	137,600	1,351,190	116,190	67.1	84.4
1978	2,272,280	326,440	1,922,350	292,210	84.6	89.5
1979	607,150	238,070	361,010	150,150	59.5	63.1
1980	993,520	246,270	581,610	162,290	58.5	65.9
1981	999,260	164,850	629,310	120,310	63.0	73.0
1982***	3,125,360	206,820	2,505,530	176,190	80.2	85.2
Mean	1,257,987	182,466	899,058	137,445	67.6	74.8
1983***	4,566,090	362,320	3,935,830	328,320	86.2	90.6

* Combined commercial harvest, sport harvest and spawning escapement.

** Includes the estimated sport harvest, personal use harvest, etc., which was taken below the sonar counter.

*** Data for these years are preliminary.

are exploited. This disparity may be as high as 17.3% as occurred in 1977.

Production per spawner data from early run Russian River fish have been available since the early 1960's as the run is harvested in significant numbers by only one user group; i.e. recreational anglers at Russian River. A knowledge of the commercial harvest of late run Kenai and Russian River fish now permits an estimation of production per spawner for these stocks since 1969. Table 17 reveals production for the early Russian River run is about 50% that of late Kenai or Russian River fish. This is to be expected as early run Russian River fish utilize the "spawning area limited" waters of Upper Russian Creek which are believed to provide a much harsher and unstable spawning and egg incubation environment than either Upper Russian Lake or the Kenai River spawning and incubation areas. The early run's limited reproductive capabilities are not presently viewed with concern as the run is exploited only by a strictly regulated sport fishery at Russian River.

Late run Russian River production per spawner from 1969 through 1972 averaged a relatively low 3.3:1 compared to Kenai River production for that same period of 6.4:1. However, Russian River production per spawner began to increase in 1973. Since 1973, the Russian River is producing at a slightly higher rate than is the Kenai River. It should be noted that late run Russian River sockeye salmon will always be exploited at a higher rate than Kenai River salmon because of the intense recreational Russian River fishery.

Late run Russian River production estimates may now be related to known spawning escapements of these fish enumerated at Lower Russian Lake weir (Table 18). In this table production figures are correlated with escapements which are categorized as "low", "intermediate" or "high".

Fry Rearing Capacity of Upper Russian Lake:

The highest average production (6.8:1) originated from escapements of less than 30,000 fish. Escapements from 30,000-50,000 produced at an average of 5.7 fish for each spawner in the parent year. Escapements in excess of 50,000 produced at the relatively low average rate of 2.8:1. These data suggest Upper Russian Lake is at or near carrying capacity. The more fry in Upper Russian Lake, the lower the survival due to competition for food and space and the lower the production per spawner. At some unknown high escapement level, the late Russian River sockeye salmon run would theoretically fail to reproduce itself.

Data to generate production figures from known escapements in Table 18 were developed by compiling commercial harvest, sport harvest, escapement and numbers of fish by age class produced by a given year class. With the exception of escapement data, these figures are estimates subject to varying degrees of error. A more simplistic approach which reduces the number of variables is to compare known Russian River late run escapements to the estimated total return to Russian River 5 years hence (Table 19). The assumption here is that all Russian River late run fish are 5 years of age and that the commercial fishery harvests this stock at a constant rate. Although these assumptions are not true, they do

Table 17. A Comparison of Early Run Russian River, Late Run Russian River and Late Run Kenai River Sockeye Salmon Return per Spawner, 1969-1979.

Brood Year	Return Per Spawner		
	Kenai River	Early Run Russian River	Late Run Russian River
1969	7.7	2.9	3.2
1970	7.2	2.3	4.7
1971	3.4	4.1	2.3
1972	7.2	10.6	3.1
1973	6.4	1.9	9.6
1974	4.2	4.0	9.8
1975	6.3	2.8	6.2
1976	3.3*	7.7	8.1*
1977	5.0*	1.1	6.7*
1978	11.1*	0.3*	2.7*
1979	2.5*	0.2*	3.0*
1969-79 Mean	5.8*	3.4*	5.4*
1973-79 Mean	5.5*	2.6*	6.6*

* All age classes for these years have not yet returned. Return per spawner is therefore minimal.

Table 18. Late Run Russian River Production Per Spawner from Years of Low, Intermediate and High Escapements, 1969-1979.

Parent Year	Parent Year Escapement	Total Return*	Return/ Spawner
		Low Escapement (<30,000)	
1969	28,920	92,540	3.2
1970	28,200	132,540	4.7
1973	24,970	239,710	9.6
1974	24,650	241,570	9.8
1977	21,410	143,450	6.7**
	Mean	169,960	6.8
		Intermediate Escapement (30,000-50,000)	
1975	31,970	198,210	6.2
1976	31,950	258,800	8.1**
1978	34,230	92,420	2.7**
	Mean	183,140	5.7
		High Escapement (<50,000)	
1971	54,430	125,190	2.3
1972	79,000	244,900	3.1
1979	87,920	263,760	3.0**
	Mean	211,280	2.8

* Commercial harvest, sport harvest and escapement.

** All age classes for these years have not yet returned. Return per spawner is therefore minimal.

Table 19. Late Run Russian River Escapements Compared to Russian River Return During Years of Low, Intermediate and High Escapements.

Parent Year	Parent Year Escapement	Return Year	Return to Russian River	Return/ Spawner
		Low Escapement (<30,000)		
1965	21,820	1970	28,800	1.3
1969	28,920	1974	33,150	1.1
1970	28,200	1975	40,360	1.4
1973	24,970	1978	58,760	2.3
1974	24,650	1979	114,750	4.7
1977	21,410	1982	40,950	1.9
		Mean	52,800	2.1
		Intermediate Escapement (30,000-50,000)		
1964	46,930	1969	30,070	0.6
1966	34,430	1971	65,160	2.0
1967	49,480	1972	95,050	2.0
1968	48,880	1973	33,900	0.7
1975	31,970	1980	117,470	3.7
1976	31,950	1981	68,250	2.1
1978	34,230	1983	47,000	1.4
		Mean	65,270	1.8
		High Escapement (<50,000)		
1963	51,120	1968	54,700	1.1
1971	54,430	1976	42,680	0.8
1972	79,000	1977	48,850	0.6
		Mean	48,740	0.8

provide a measure of consistency when comparing the annual return to Russian River with the parent year escapement.

In Table 19 production per spawner is highest when escapements are below 30,000. At the intermediate escapement range, production per spawner declined. Escapements of 50,000 and higher failed to reproduce themselves. Tables 18 and 19 are therefore in agreement as they indicate an inverse relationship between numbers in the spawning escapement and production per spawner. As escapement increases, production per spawner decreases.

Further evidence that the carrying capacity of Upper Russian Lake has either been reached or is being rapidly approached is indirectly provided by Burgner et al. (1969). These investigations ranked selected sockeye salmon nursery lakes in southwestern Alaska based on adult escapement per km^2 of surface area. If Upper Russian Lake is added to this list the ranking is:

System	Escapement/km^2
Upper Russian	13,070
Karluk	8,350
Chignik	8,070
Igushik	4,360
Wood	2,340
Alagnak	1,441
Ugashik	1,330
Kvichak	1,330
Naknek	1,122
Snake	290
Nuyakuk	280

Incorporating 20 years of escapement data into the above, Upper Russian Lake ranks first in terms of escapement per km^2. The mean escapement to this lake has increased since the 1960's. From 1966-1977 it was 10,652 and from 1978 to present, 19,343.

Although not definitive, the "Number 1" ranking of Upper Russian Lake in terms of escapement per unit of surface area suggests it is at or near carrying capacity. A similar conclusion was reached through analysis of the available plankton which is the primary source of food for rearing sockeye salmon.

Jeff Koenings, limnologist with the Alaska Department of Fish and Game in Soldotna, compared zooplankton from Upper Russian Lake (a high sockeye salmon producer) with Hidden Lake (a low sockeye salmon producer). One species of zooplankton which is preferred by sockeye, Daphnia galeata mendota, is prevalent in Hidden Lake, but completely absent in Upper Russian Lake. The mean size of Daphnia longiremus and Bosmina longirostris is appreciably larger in Hidden than Upper Russian Lake. Additionally, Upper Russian Lake sockeye salmon generally rear for 2 years as opposed to 1 year at Hidden Lake. At smoltification, Hidden Lake fish are significantly larger than smolt from Upper Russian Lake. The conclusion is that rearing sockeye have completely eliminated Daphnia

galeata mendota from Upper Russian Lake. The remaining two species are cropped to the degree that they never achieve a large mean size.

Sockeye salmon fry rear for 2 years in Upper Russian Lake as opposed to 1 year in Hidden Lake due to a limited food source in Upper Russian Lake (Jeff Koenings, Limnologist, Alaska Department of Fish and Game, Soldotna, Alaska, pers. comm.). Increasing the spawning escapement in Upper Russian Lake will therefore not result in increased production per spawner. Available data indicate increased escapements will actually decrease production per spawning fish.

Evaluation of Escapement Goals:

Escapement data suggest the total number of early and late run fish in the spawning escapement should approximate the sum of the historical early and late run escapements prior to 1978. From 1963-1977 the early and late run escapement averaged 11,550 and 38,550 fish, respectively, or a total of 50,100. Jeff Koenings (pers. comm.) assessed carrying capacity of Upper Russian Lake through analysis of water quality and available plankton. He concluded the optimum sum of early and late run escapements should approximate 62,500. Ken Tarbox (pers. comm.) analyzed the late run escapement to adult return ratio. Data indicated maximum late run production would be achieved with a parent year escapement approximating 41,800.

Three different parameters have therefore been applied to determine early and late run Russian River sockeye salmon escapement goals; i.e., historical escapement levels, water quality and available plankton as well as an analysis of the late run escapement to return ratio. Results obtained from these three approaches are in basic agreement. Optimum combined early and late run escapement should approximate 62,500. Maximum early run production is achieved with escapements between 9,000 and 15,000 fish. To date, return from an escapement in excess of 20,000 has failed to reproduce itself. The late run escapement should range from 30,000-50,000 fish with escapements approximating 40,000 being desirable.

The salient point is that all data examined indicate Upper Russian Lake is currently at or approaching carrying capacity. There is undoubtedly intense competition between age classes of early and late run rearing fish for available food and space.

Failure of the 1978 Year Class and Stock Status:

Total 1983 late run Russian River return including commercial harvest, sport harvest and escapement was 362,230 fish. This run is historically comprised primarily of 5-year fish of age class 2.2. The return in 1983 would be expected to be predominantly from the 1978 parent year escapement. This, however, did not occur (Table 20). Return in 1983 was primarily the age class 1.2 component from the 1979 parent year which indicates the relative failure of the 1978 year class.

Failure of the 1983 late run age class 2.2 component from the 1978 spawning escapement is believed related to competition with other early

Table 20. Estimated Return by Age Class of Late Run Russian River Sockeye Salmon, 1972-1983.

Year	1.2 (4 2)	1.3 (5 2)	2.2 (5 3)	2.3 (6 3)	3.2 (6 4)	3.3 (7 4)	Sport Harvest	Commercial Harvest	Total Harvest	Escape-ment	Total Return
1972	...	...	...	...	...	...	16,050	144,370	160,420	79,000	239,420
1973	...	...	...	...	...	...	8,930	43,850	52,780	24,970	77,750
1974	4,810	7,870	51,260	23,530			8,500	54,320	62,820	24,650	87,470
1975	7,010	3,760	85,520	31,010	2,470		8,390	89,410	97,800	31,970	129,770
1976	16,640	6,560	90,990	36,030	1,530	920	13,700	107,020	120,720	31,950	152,670
1977	9,080	10,600	99,900	18,020			27,440	88,750	116,190	21,410	137,600
1978	2,940	17,300	191,950	114,250			24,530	267,680	292,210	34,230	326,440
1979	5,000	950	209,980	19,520	2,140	480	26,830	123,320	150,150	87,920	238,070
1980	62,060	18,220	139,390	26,600			33,490	128,800	162,290	83,980	246,270
1981	22,750	10,880	99,240	31,160	820		23,720	96,600	120,320	44,530	164,850
1982*	18,200	5,790	95,140	81,070	4,140	2,480	10,320	165,870	176,190	30,630	206,820
Mean	16,499	9,103	118,152	42,354	1,233	431	18,354	119,090	137,445	45,022	182,466
1983*	267,030	28,990	45,650	20,650			16,000	312,320	328,320	34,000	362,320

* Data from these years are preliminary.

and late run age classes in Upper Russian Lake. The progeny from the 1978 late run escapement competed with late run rearing fry from the 1976 and 1977 parent years. Both these parent year escapements were less than 35,000 fish. However, this year class also competed with early run rearing fish from 1976, 1977 and 1978. These early run escapements were all above average and the 1978 escapement was the highest to date. It is reasonable to assume fry from the 1978 late run escapement could not successfully compete with the numbers of fry produced by three consecutive large early run escapements.

Both early and late Russian River sockeye salmon runs have increased. From 1972 through 1977 the combined average early and late run production (includes commercial harvest) was 156,670. To this total the early run contributed 12.3% and the late run 87.7%. From 1978 to 1983 total production increased nearly 100% to 308,771. The percentage contribution to this total by the respective runs did not appreciably change. The return to Russian River has also increased. From 1963-1977 the mean annual early and late run return was 64,900. The early run contributed 28.3% and the late run 71.7%. From 1978 to present the total return to Russian River increased to 125,800. During this period the early run contribution increased to 40.8% and the late run contribution declined to 59.2%. In 2 of the 6 years the early run return exceeded the number of fish in the late run. This did not occur prior to 1978.

Since Upper Russian Lake appears to be at or near carrying capacity, continued increases in the magnitude of the early and late run cannot continue without affecting a segment of the run. The data suggest that the effects may already be apparent as the late run's contribution to the total Russian River return has declined in relation to the early run's increasing contribution to total return as well as to total escapement. Management strategies and principles as they relate to Russian River stocks must therefore be reviewed to ensure that spawning escapement goals are met and maximum production realized from both early and late runs.

Management Concerns:

Management of the early run poses relatively few problems. The stock is currently at a high level and is harvested only by a restrictive sport fishery. The escapement goal has been consistently achieved. Management of the late run is more complex. This stock is harvested by a highly efficient mixed stock commercial fishery in addition to an intense sport fishery. In recent years the minimum escapement goal has been achieved only by closure of the sport fishery. Overexploitation is an annual possibility.

Examination of total return in Table 18 reveals an average production of 169,960 fish when late run parent year escapements are less than 30,000 fish. The average commercial exploitation rate (Table 16) is 67.6%. Employing these figures, the average commercial harvest would be 114,890 with a return to Russian River of 55,070. The Russian River late run sport fishery is currently capable of harvesting approximately 1,000 fish daily. The fishery is of approximately 30 days duration. An emergency

closure may therefore be necessary to achieve the minimum escapement goal of 30,000.

The return from an escapement of 30,000-50,000 averages 183,140. At the mean exploitation rate the commercial fishery would harvest 123,800 with 59,340 returning to Russian River. Again, an emergency closure may be necessary. An escapement in excess of 50,000 fish produces 211,280. At an exploitation rate of 67.6%, 142,825 fish would be harvested commercially and 68,455 would return to Russian River. The minimum escapement would theoretically be 38,455 and the sport fishery would harvest 30,000 late run sockeye salmon.

In the above calculations, the mean commercial harvest rate of 67.6% was used. In recent years the exploitation rate has been as high as 86.2%. Given available late run Russian River production data when the commercial exploitation rate of Kenai River fish including Russian River exceeds 72.2%, it may be necessary to close the Russian River sport fishery to achieve the minimum escapement. This closure will occur irrespective of the parent year Russian River escapement.

Table 21 depicts the actual correlation between numbers of late run Russian River sockeye salmon produced, the commercial exploitation rate and emergency closures for stock conservation purposes at Russian River from 1975-1983. Only data since 1975 are presented as 1975 is the initial year the late run minimum escapement goal of 30,000 was mandated by Alaska Fisheries Board policy.

Emergency closures were required in 1975, 1977, 1978, 1982 and 1983. The commercial exploitation rate during these years ranged from 67.1% to 86.2% with a mean of 78.1%. The mean escapement and sport harvest was 30,450 and 17,340 fish, respectively. Emergency closures were not required during the remaining 4 years. The exploitation rate by the commercial fishery during these years ranged from 58.5 to 72.6% with a mean of 63.4%. Mean escapement during these years was 62,100 and the sport harvest 24,440. The 2 years in which Russian river experienced its highest late run production, which was in excess of 300,000 fish (1978; 1983), an emergency closure of the sport fishery was required. These years of highest production corresponded to the 2 years of highest commercial exploitation (84.6 and 86.2%).

The correlation between high commercial exploitation rates and emergency closures during the late run Russian river sockeye salmon fishery is evident. The higher the exploitation rate in the commercial fishery, the greater the probability of an emergency closure for stock conservation during the sport fishery.

The increasing efficiency of the Russian River angler also contributes to the probability of an emergency closure. In 1975 the mean late run Russian River harvest was approximately 500 fish per day. Due to increased angler effort and a better general knowledge of the fishery, anglers harvested 1,333 fish per day in 1983.

Ensuring an adequate return of late run fish to Russian river, which will be sufficient for recreational and escapement needs, becomes even more

Table 21. The Commercial Exploitation Rate and Its Relationship to Emergency Closures for Stock Conservation During the Late Run Russian River Sport Fishery, 1975-1983.

Year	Total Russian River Production	Late Run Russian River Escapement	Commercial Exploitation Rate	Emergency Closure Required for Stock Conservation
1975	129,770	31,970	72.2	Yes
1976	152,670	31,950	72.6	No
1977	137,600	21,410	67.1	Yes
1978	326,440	34,230	84.6	Yes
1979	238,070	87,920	59.5	No
1980	246,270	83,980	58.5	No
1981	164,850	44,530	63.0	No
1982	206,820	30,630	80.2	Yes
1983	362,320	34,000	86.2	Yes

difficult when the magnitude of the mainstem Kenai River escapement is compared to the Russian River escapement. During the last cycle (5 years) the Kenai River escapement has ranged from 322,000 to 630,000 with a mean of 488,800. During this same period Russian River late run escapement has ranged from 30,630 to 87,920, averaging 40,412. The mainstem Kenai River escapement on the average exceeds Russian River escapement by a factor of 12.

High Kenai and correspondingly low Russian River escapements lead directly to the following scenario: Assume a Kenai River parent escapement of 500,000 and a corresponding Russian River escapement of 30,000. Assume both systems are producing six fish for each spawner. Return to the Kenai and Russian Rivers would be 3,000,000 and 180,000, respectively. From the Kenai River return the commercial fishery could harvest 2,500,000 with the remaining 500,000 for escapement. This is an exploitation rate of 83.3%. At this rate only 30,000 of the original 180,000 Russian River fish would return to Russian River. This would not permit a recreational fishery.

The above scenario has infinite combinations. The conclusion, however, is the same with virtually any reasonable combination: As long as production in the Kenai and Russian Rivers is similar and as long as Kenai River escapements remain disproportionately high in relation to Russian River, a high exploitation rate in the commercial fishery will eventuate. This high exploitation rate will not permit sufficient numbers of fish to return to Russian River to satisfy the needs of the recreational fishery and spawning escapement.

Synopsis:

Early and late run escapement goals established in 1975 are appropriate for the Russian River drainage. Maximum early run production is achieved with escapements from 9,000 to 15,000 fish. Limited data suggest early run escapements above 20,000 sockeye salmon fail to reproduce themselves. The late run minimum escapement goal of 30,000 is adequate. Desired escapement for this stock is 30,000 to 50,000. All data suggest Upper Russian Lake is at carrying capacity. Total early and late run escapement to the drainage will produce maximum returns if these combined escapements approximate 62,500 sockeye salmon.

Early run Russian River sockeye salmon returns are currently at high levels. This stock is harvested only by the intensely managed recreational fishery at Russian River. There are presently no major management concerns associated with these fish.

Late run Russian River sockeye salmon are harvested by the Cook Inlet commercial and Russian River sport fisheries. The commercial fishery is managed in large part on the return of Kenai River sockeye salmon (Ken Tarbox, pers. comm.). Kenai River fish receive minimal exploitation from recreational anglers while the Russian river sport fishery is the most intensely utilized fishery in Alaska. Late run Russian River fish are therefore always exploited at a higher rate than are Kenai River fish. In some years this exploitation rate may be 17.1% higher than the rate Kenai River sockeye salmon are subjected to.

Total production and subsequent spawning escapements of Kenai River fish have been high in recent years. Production and total return of late run Russian River fish has also been high but, because of the exploitation by commercial and sport user groups, escapements have been relatively low in some years. High escapements to the Kenai River, low escapements in Russian River and high exploitation of Russian River fish in both the commercial and sport fishery will require conservative management of the Russian River sport fishery if the late run escapement goal in this system is to be achieved.

Age Class Composition

Scale samples collected at Lower Russian Lake weir revealed sockeye salmon in their sixth year of life comprised 48.1% of the early run. Salmon in their fifth year of life contributed 40.2%. Four and 7 year old fish contributed the remaining 11.2 and 0.5%, respectively. These components approximate the historic age class composition of the early run. Male to female sex ratio was 1:0.9.

Early run salmon averaged 585.5 mm (23.1 in) in length. Mean lengths of two and three-ocean fish were 532.0 mm (21.0 in) and 594.2 mm (23.4 in), respectively (Table 22).

Late run stocks were dominated by fish which resided 1 year in freshwater (81.7%). This is atypical as historically over 85% of this run is dominated by fish which rear in the freshwater environment for 2 years. The majority of the run (86.3%) spent 2 years in saltwater prior to returning to their natal stream. Male to female sex ratio (excluding jacks) was 1:1.7. Late run sockeye salmon averaged 542.2 mm (21.4 in), which is 43.3 mm (1.7 in) less than the average early run fish. This length differential occurs annually and has been previously discussed (Nelson, 1982).

Three-ocean early and late run fish averaged 594.2 mm (23.4 in) and 605.8 mm (23.9 in), respectively. Late run fish are generally larger than early run fish of similar ocean residence as the late run remains in the marine environment approximately 1 month longer than the early run during their final year of life. Age class composition data for the 1983 early and late run are summarized in Table 23.

Table 24 summarizes historical early and late run Russian River sockeye salmon age class composition. The dominance of age class 2.3 in the early and 2.2 in the late run is clearly shown. The exceptions to the dominance of age class 2.3 in the early run occurred in 1977 and 1981. The atypical age structure during these years has been discussed (Nelson, 1978, 1982). Age class 2.2 has consistently been the prevalent age class in the late run with the exception of 1983 when age class 1.2 dominated. Reason(s) for the dominance of this age class from the 1979 spawning escapement are not definitely known. However, the dominance of age class 1.2 is believed related to the failure of the 1978 late run parent year to produce significant numbers of fish. If the factors contributing to the failure of the 1978 brood year were present in Upper Russian Lake, then the progeny of the 1979 spawning escapement would not have had to compete with larger numbers of rearing fry from the 1978 escapement for

Table 22. Early and Late Run Russian River Sockeye Salmon Total Returns and Mean Lengths by Ocean-Age of Fish Sampled, 1975-1983.

Year	Total Return**	Mean Length (mm)* Two-Ocean Salmon	Three-Ocean Salmon	Combined
		Early Run		
1975	7,040	542.1	600.7	588.7
1976	18,090	562.4	609.4	591.5
1977	36,470	559.6	610.5	598.2
1978	71,870	551.5	604.5	602.0
1979	28,100	550.1	610.8	605.3
1980	55,890	543.5	597.1	595.8
1981	31,860	549.8	601.8	588.3
1982	90,580	540.0	589.7	589.5
Mean	42,488	549.9	603.1	594.9
1983	29,560	532.0	594.2	585.5
		Late Run		
1975	40,360	552.2	603.2	561.3
1976	45,650	571.5	618.6	585.0
1977	48,850	553.7	614.9	570.5
1978	58,760	549.8	602.7	566.9
1979	114,750	541.6	610.3	548.0
1980	117,480	544.2	600.9	562.7
1981	68,250	544.8	608.9	560.5
1982	40,950	531.1	597.2	559.7
Mean	66,881	548.6	607.1	564.3
1983	50,000	532.1	605.8	542.2

* Lengths are from mid-eye to fork of tail.
** Total return is exclusive of late run sockeye salmon spawning below Russian River Falls.

Table 23. Age Class Composition, Sample Size, Parent Year and Mean Lengths of Adult Sockeye Salmon in Respective Age Classes for Early and Late Run Russian River Escapements, 1983.

Age Class	Estimated Number in Escapement	Sample Size	Estimated Percent of Escapement	Parent Year	Mean Length (mm)*	S.D.**
			Early Run			
2.3	10,150	103	48.1	1977	594.7	18.3
1.3	7,892	80	37.4	1978	594.0	21.1
1.2	2,363	24	11.2	1979	531.9	20.8
2.2	591	6	2.8	1978	532.5	19.2
3.3	106	1	0.5	1976	550.0	...
Combined	21,102***	214	100.0		585.5****	29.3****
			Late Run			
1.2	21,845	129	73.7	1979	531.4	28.5
2.2	3,735	22	12.6	1978	536.1	38.2
1.3	2,371	14	8.0	1978	607.1	17.1
2.3	1,689	10	5.7	1977	604.0	21.9
	29,640***	175	100.0		542.2****	38.3****

* Mean lengths are from mid-eye to fork of tail.
** Standard deviation.
*** Excludes 98 and 4,360 jacks in the early and late run, respectively.
**** Mean lengths and standard deviation computed from total sample.

Table 24. Age Class Composition in Percent of Early and Late Run Adult Russian River Sockeye Salmon Escapements, 1970-1983.

Year	Age Class 1.2	1.3	1.4	2.2	2.3	2.4	3.2	3.3
				Early Run				
1970	0.4			8.9	87.1	3.6		
1971	1.1	3.2		6.4	89.3			
1972	3.0	38.0		8.4	50.0	0.6		
1973	...	...	...	...	...	...	...	...
1974	0.5	32.0		3.4	63.6	0.5		
1975	0.4	1.8	0.4	19.7	75.1	0.4		
1976	16.8	1.5		11.4	61.1		0.9	1.3
1977	1.9	60.7		14.0	23.4		0.8	8.4
1978	0.9	3.0		1.6	95.3			
1979		4.5		20.9	74.6			
1980	6.2	8.1	0.4	4.3	81.0			
1981	6.3	46.5		18.9	28.3			
1982		1.2		0.4	98.4			
Mean	3.1	16.7	0.1	9.9	68.9	0.4	0.1	0.8
1983	11.2	37.4		2.8	48.1			0.5
				Late Run				
1970	2.5	2.9		87.3	7.3			
1971	1.9	5.3		61.5	30.3			
1972	...	...	...	...	...	...	...	...
1973	...	...	...	...	...	...	...	...
1974	5.5	9.0		58.6	26.9			
1975	5.4	2.9		65.9	23.9		1.9	
1976	10.9	4.3		59.6	23.6		1.0	0.6
1977	6.6	7.7		72.6	13.1			
1978	0.9	5.3		58.8	35.0			
1979	2.1	0.4		88.2	8.2		0.9	0.2
1980	25.2	7.4		56.6	10.8			
1981	13.8	6.6		60.2	18.9		0.5	
1982	8.8	2.8		46.0	39.2		2.0	1.2
Mean	7.6	5.0		65.0	21.6		0.6	0.2
1983	73.7	8.0		12.6	5.7			

food and space. Reduced competition would have resulted in accelerated growth rates for these fry and smoltification would have occurred after 1 year rather than the traditional 2 years.

Length frequency of 214 early run sockeye salmon is presented in Figure 5. This figure indicates 79.9% of these fish exceeded 569 mm (22.4 in). whereas Figure 6 reveals only 23.4% of the late run exceeded this length. This length differential is again a function of the age structure of the respective populations.

Given the basic premise that the early and late runs are comprised of two and three-ocean salmon, Figure 5 suggests a division of early run ocean ages at 569 mm (22.4 in). Calculating the ocean age of early run fish employing these length frequency data reveals 20.1% of the run would be two-ocean and the remaining 79.9% three-ocean. Scale analysis indicated 14.0 and 86.0% were two and three-ocean fish, respectively. Length could therefore be employed as an indicator of ocean age for the 1983 early run.

Figure 6 is not as definitive as length frequency data in Figure 5. However, it does suggest a division of two and three-ocean late run fish at 559 mm (22.0 in). Employing length frequency data, 70.9 and 29.1% of the late run would be two and three-ocean fish, respectively. Scale analysis revealed the ocean age composition of this stock was 86.3% two-ocean and 13.7% three-ocean. Length frequency data alone would therefore provide only a gross approximation of the ocean ages of the 1983 late run.

Early Run Return Per Spawner

Table 25 presents the numbers of fish produced for each early run fish in the parent year spawning escapement. From 1963-1976, the return per spawning fish in the parent year escapement averaged 30, ranging from 0.2 to 10.6. The significance of a return of 10.6 for each salmon in the escapement has been discussed (Nelson, 1979). As previously noted in this report, a large spawning escapement does not ensure a high return rate. The lowest return per spawner (0.2) was produced by the largest parent year escapement (21,510). Conversely, the return rate of 10.6 originated with a relatively low spawning escapement of 9,270.

Foerster (1968) indicates that irrespective of the level of escapement, fluctuations in the numbers of returning adult fish are quite marked. As an example, this author cites the Fraser River return per spawner from 1938 to 1954 which ranged from 2.2 to 13.0, averaging 5.4. He concluded most of the variability in production is attributable to environmental conditions during the freshwater developmental stages.

Return per spawner for the 1977 parent year, which returned as adults in 1982 and 1983, was a relatively low 1:1.1. A return of this magnitude was not unexpected. In 1977 high water in Russian River Falls impeded the early run migration. A "fish rescue" was undertaken and a segment of the run transported over the barrier via helicopter. The 1977 early run encountered a prolonged delay in addition to physical injury prior to

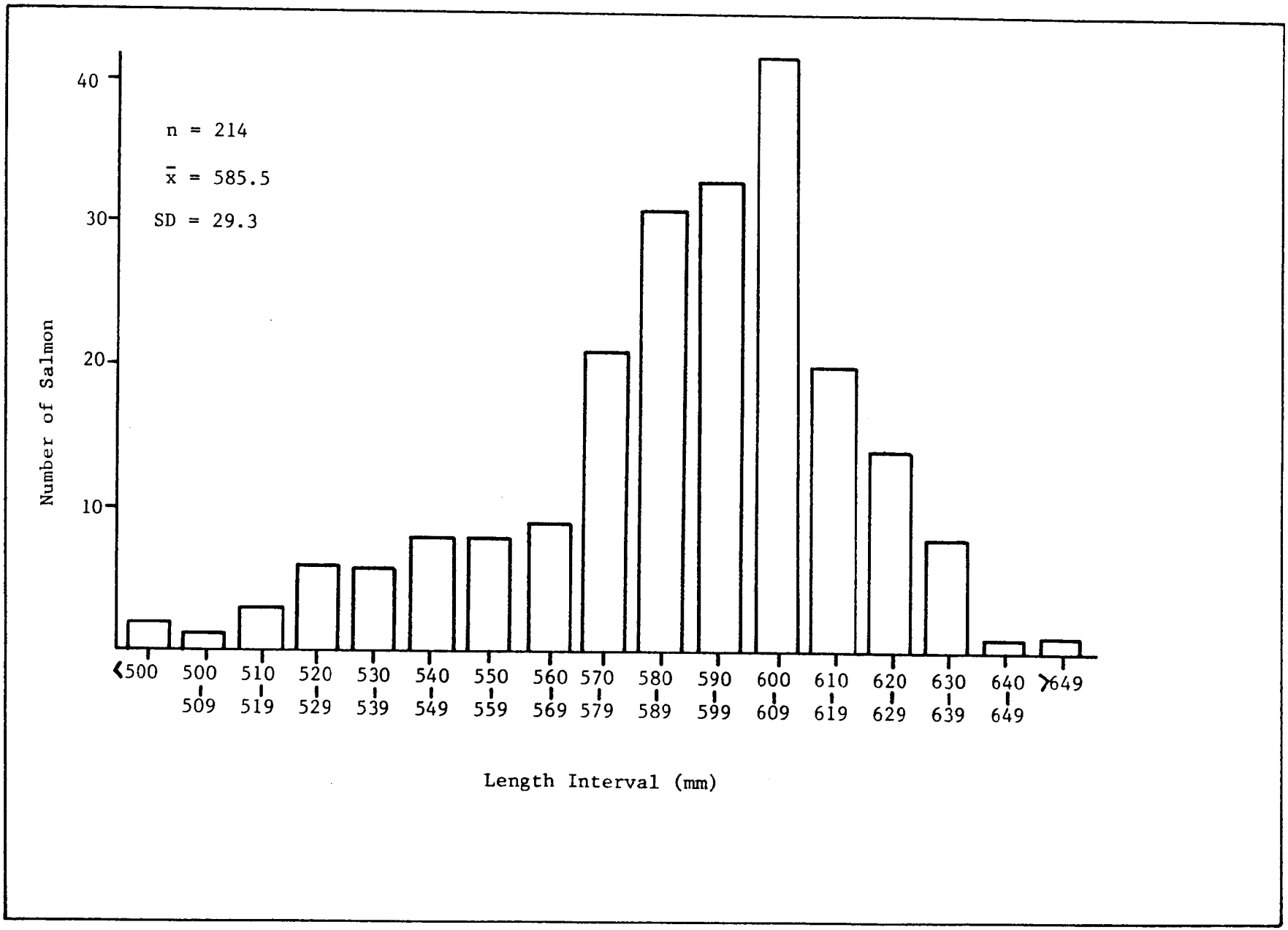

Figure 5. Length Frequency of Early Run Russian River Sockeye Salmon Sampled at Lower Russian Lake Weir, 1983.

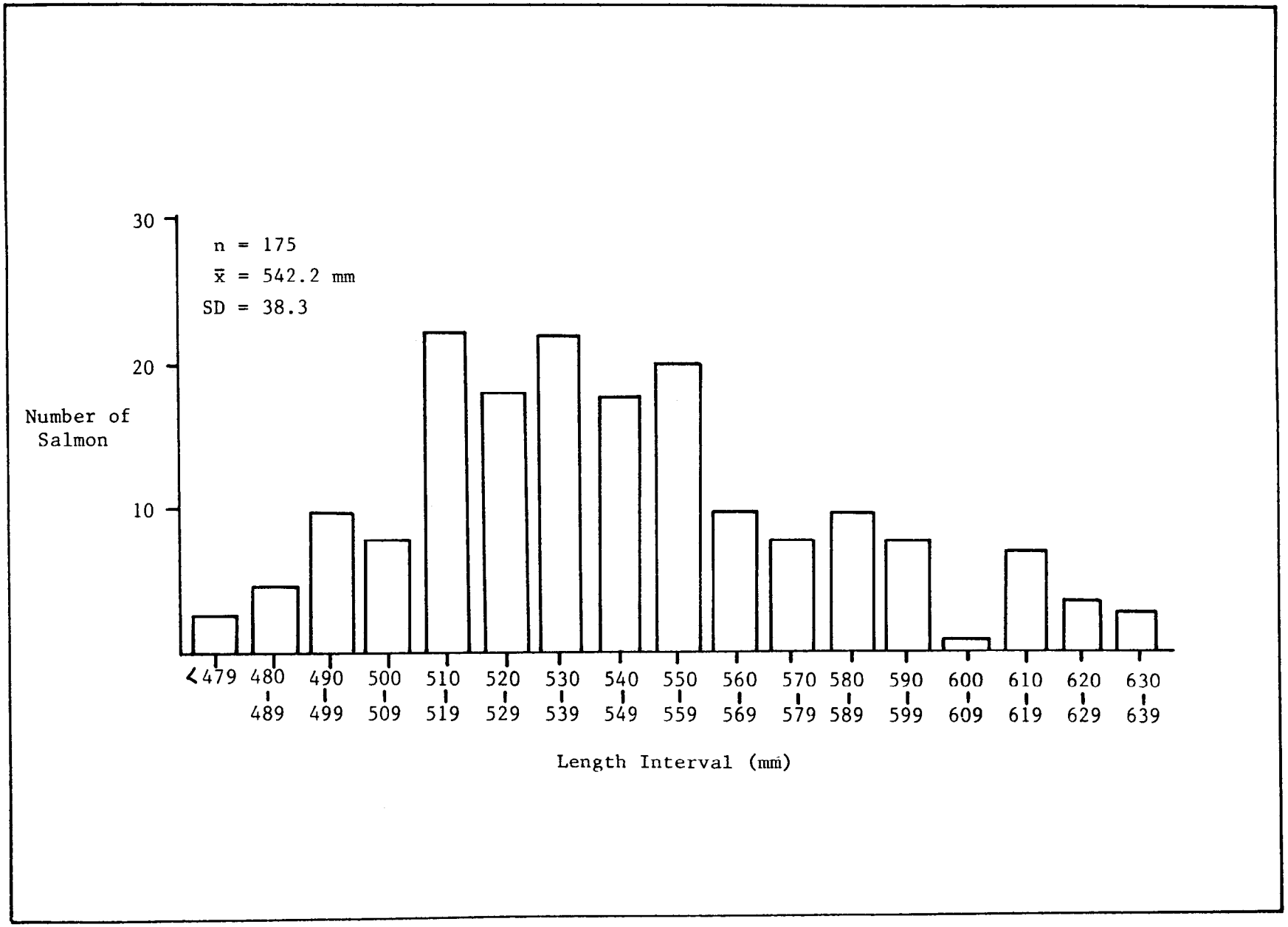

Figure 6. Length Frequency of Late Run Russian River Sockeye Salmon Sampled at Lower Russian Lake Weir, 1983.

Table 25. Estimated Production From Known Escapements of Early Run Russian River Sockeye Salmon, 1963-1977.

Parent Year	Parent Year Escapement	Total Return (Production)*	Return Per Female	Return Per Spawner
1963	14,580	10,870	1.5**	0.7**
1964	12,700	11,200	1.8**	0.9**
1965	21,510	4,875	0.4**	0.2**
1966	16,660	8,183	1.0	0.5
1967	13,710	19,628	2.8	1.4
1968	9,200	18,946	4.0	2.0
1969	5,000	14,508	5.8	2.9
1970	5,450	12,810	5.3	2.3
1971	2,650	10,896	8.7	4.1
1972	9,270	98,775	26.6	10.6
1973	13,120	24,962	3.8	1.9
1974	13,150	52,704	9.7	4.0
1975	5,640	15,947	4.6	2.8
1976	14,700	113,580	15.5	7.7
Mean	11,239	29,849	6.5	3.0
1977	16,070	17,674	3.8	1.1

* Total return equals sport harvest plus escapement. A negligible commercial harvest is assumed.

** Assumes a male to female sex ratio of 1:1.0 in the parent year escapement. Sex ratios for succeeding years were determined by sampling.

reaching the spawning grounds in Upper Russian Creek. Their ability to spawn successfully was therefore questionable (Nelson, 1978).

Fecundity Investigations

Fecundity investigations initiated in 1973 were continued during the 1983 season. Data from 1983 early and late run investigations are presented in Tables 26 and 27, respectively.

Early run fish sampled averaged 2.2 kg (4.9 lb) in weight and 563.0 mm (22.2 in) in length. These fish averaged 1,380 eggs/kg of body weight and 5.6 eggs/mm of body length. Mean fecundity of early run fish was 3,063 eggs/female. Average weight and length of late run fish was 2.2 kg (4.9 lb) and 548 mm (21.6 in), respectively. Late run fish averaged 1,168 eggs/kg of body weight and 4.7 eggs/mm of body length. Table 28 compares early and late run fecundity with results from prior years.

Mean fecundity of early run fish in 1983 was the lowest recorded. Similarly, the mean size (both weight and length) of fish comprising the sample was the smallest to date. Low average fecundity is therefore to be expected as there is generally a direct relationship between the size of a female sockeye salmon and egg content (Foerster, 1968). The mean fecundity of the late run fish was also the lowest recorded. Average weight and length of these fish was at the lower end of the historical range.

Egg Deposition

Assuming the mean fecundity of early run fish is representative of early run stocks, the potential number of eggs available for deposition in Upper Russian Creek may be calculated. Losses between weir and spawning grounds, females which perish without spawning and mean number of eggs retained per spent female must be considered. Nelson (1976) has presented a detailed discussion of these criteria and the methodology employed to calculate potential early run egg deposition. Deposition in 1983 was estimated at 28.3 million. Table 29 presents early run potential egg deposition estimates since 1972.

Inspection of Table 28 reveals the greater the spawning escapement the greater the potential egg deposition. However, some variability in reproductive potential will occur annually irrespective of the number of salmon in the spawning escapement in that mean fecundity and male to female sex ratio are not constant (Hartman and Conkle, 1960). It should also be noted that neither a definitive nor direct relationship is evident between numbers in the spawning escapement, potential eggs available for deposition and adult return. Factors other than eggs available for deposition therefore exert a significant influence on the adult return of early run sockeye salmon. Foerster (1968) believes these factors are manifest primarily during freshwater residency and are environmentally related.

Egg sampling to determine actual egg deposition in Upper Russian Creek was not conducted in 1983. It was previously believed that hydraulic egg sampling would permit an evaluation of spawning success (number of eggs

Table 26. Fecundity of Early Run Russian River Sockeye Salmon as Determined by Sampling at Lower Russian Lake Weir, 1983

Sample Number	Weight kg	Weight lb	Length (mm)	Number of Eggs Right Skein	Number of Eggs Left Skein	Number of Eggs Combined
1	2.7	6.0	605	1,920	2,101	4,021
2	2.3	5.0	555	1,568	1,634	3,202
3	2.4	5.4	590	1,522	1,919	3,441
4	1.7	3.7	560	1,038	1,394	2,432
5	2.3	5.2	580	1,691	1,895	3,586
6	1.5	3.3	505	1,104	1,385	2,489
7	2.7	6.0	590	1,909	1,766	3,675
8	2.6	5.7	580	1,223	1,559	2,782
9	2.3	5.0	565	1,450	1,404	2,854
10	1.9	4.3	535	868	1,152	2,020
11	2.0	4.5	545	1,527	1,695	3,222
12	2.1	4.6	540	1,439	1,592	3,031
Mean	2.2	4.9	563	1,438	1,625	3,063

Table 27. Fecundity of Late Run Russian River Sockeye Salmon as Determined by Sampling at Lower Russian Lake Weir, 1983.

Sample Number	Weight kg	Weight lb	Length (mm)	Number of Eggs Right Skein	Number of Eggs Left Skein	Number of Eggs Combined
1	1.6	3.5	505	1,122	1,204	2,326
2	2.3	5.0	565	1,502	1,262	2,764
3	2.4	5.3	560	1,467	965	2,432
4	2.1	4.7	555	1,209	1,350	2,559
5	1.8	4.0	500	1,134	1,141	2,275
6	2.4	5.2	565	1,269	1,755	3,024
7	1.9	4.2	525	1,132	1,185	2,317
8	1.9	4.3	540	838	1,038	1,876
9	2.9	6.3	590	1,188	1,588	2,776
10	2.4	5.3	550	1,276	1,323	2,599
11	2.7	6.0	580	1,328	1,768	3,096
12	2.1	4.7	540	1,316	1,755	3,071
Mean	2.2	4.9	548	1,232	1,361	2,593

Table 28. A Comparison of Fecundity Data Collected At Lower Russian Lake Weir During Early and Late Run Russian River Sockeye Salmon Migrations, 1973-1983.

Year	Mean Fecundity	Mean Length (mm)	Mean Weight (kg)	Eggs/ Kilogram	Eggs/ Millimeter
		Early Run			
1973	4,630	627.0	2.97	1,559	7.4
1974	3,569	603.0	2.60	1,373	5.9
1975	3,952	600.0	2.54	1,556	6.6
1976	3,668	596.0	2.61	1,405	6.1
1977	4,313	602.7	2.85	1,513	7.1
1978	3,815	608.1	2.82	1,353	6.3
1979	3,842	577.0	2.49	1,543	6.7
1980	3,534	572.9	2.42	1,460	6.2
1981	3,412	570.4	2.32	1,471	6.0
1982	3,479*	587.7	2.64	1,318	5.9
Mean	3,821	594.5	2.63	1,455	6.4
1983	3,063	547.9	2.22	1,380	5.6
		Late Run			
1973	3,190	569.0	2.19	1,457	5.6
1974	3,261	558.0	2.30	1,418	5.8
1975	3,555	555.0	2.26	1,573	6.4
1976	3,491	587.0	2.53	1,380	5.9
1977	3,302	567.1	2.44	1,353	5.8
1978	2,865	584.0	2.67	1,073	4.9
1979	3,314	542.0	2.20	1,506	6.1
1980	2,740	543.7	1.98	1,384	5.0
1981	3,268	551.7	2.15	1,520	5.9
1982	3,702	593.3	2.72	1,361	6.2
Mean	3,269	565.1	2.34	1,403	5.8
1983	2,593	547.9	2.22	1,168	4.7

* Fecundity calculated by linear regression. Correlation coefficient between length (x) and fecundity (y) equals 0.75.

Table 29. Potential Egg Deposition From Early Run Sockeye Salmon Escapement in Upper Russian Creek and Known Adult Returns Produced From a Given Number of Eggs Deposited, 1972-1983.

Year	Escapement	Potential Egg Deposition (millions)	Adult Return
1972	9,270	15.0	98,773
1973	13,120	29.6	24,962
1974	13,150	17.7	52,704
1975	5,640	12.7	15,947
1976	14,700	23.5	113,580
1977	16,070	18.2	17,674
1978	34,150	62.8	
1979	19,700	30.9	
1980	28,670	44.2	
1981	21,140	32.0	
1982	56,080	89.7	
1983	21,200	28.3	

Table 30. Climatological and Hydrological Observations by Six-Day Periods Recorded at Lower Russian Lake Weir, June 13-September 4, 1983.

Period	Water Temp.*		Air Temp.*		Rainfall	Russian R. Discharge	Rondezvous Ck. Discharge
	Max°C	Min°C	Max°C	Min°C	(mm)**	(cfs)	(cfs)
June 13-18	11.1	10.2	16.0	14.4	1.7	257.2	43.3
June 19-24	12.4	11.1	16.2	15.5	0.0	208.9	58.2
June 25-30	12.7	11.2	15.7	14.8	1.3	207.7	71.1
July 1-6	12.9	12.0	17.3	16.0	7.9	188.4	57.8
July 7-12	12.5	12.1	14.8	14.4	9.5	155.5	50.0
July 13-18	14.5	13.3	19.7	13.2	2.2	161.7	47.5
July 19-24	14.0	13.3	19.5	16.6	3.4	148.4	43.0
July 25-30	16.4	11.6	19.1	14.5	1.5	124.7	34.5
July 31-Aug. 5	17.3	13.9	20.9	14.5	30.3	127.8	28.4
Aug. 6-11	16.1	13.1	18.2	11.5	13.1	150.2	31.6
Aug. 12-17	14.9	12.1	16.0	5.3	11.1	125.8	24.5
Aug. 18-23	14.3	11.9	16.4	7.2	8.0	113.0	18.3
Aug. 24-29	14.1	11.7	15.7	6.2	5.2	101.4	15.3
Aug. 30-Sept. 4	13.3	10.9	15.3	6.4	2.1	101.9	15.8

* Air and water temperature for the respective periods are the mean of the daily recordings.
** Rainfall for each period is the cumulative total of the daily recordings.

deposited) as this success was related to environmental parameters present during the spawning and early portion of the egg incubation period. It was further assumed that there was a direct relationship between egg density and the return of adult early run fish 6 years later. Data analysis reveals this latter assumption is not valid. These data were extensively reviewed by Nelson (1983) and indicated no relationship between eggs in the gravel at time of sampling and adult return 6 years hence.

Returns of early run Russian River sockeye salmon are apparently subject to factors other than or in addition to egg density; i.e., carrying capacity of Upper Russian Lake, predation during saltwater residency, relationship of early run rearing fish to late run rearing fish, marine survival, etc. Until these parameters are identified, there is no value in continuing to determine actual early run egg deposition in Upper Russian Creek.

Climatological Observations

Climatological data recorded at Lower Russian Lake weir were grouped by 6-day periods to facilitate analysis (Table 30). No correlation was found between air and water temperatures and sockeye salmon migration. These temperatures were comparable to prior years' data. Total precipitation between June 13 and September 4 was 97.3 mm (3.8 in). This rainfall is less than the amounts recorded in 1980, 1981 or 1982 and resulted in below average flow through Russian River Falls during the 1983 season.

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